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THE DEVELOPMENT OF AMERICAN INDUSTRIES SINCE COLUMBUS.

VI. THE EVOLUTION OF WOOL SPINNING AND WEAVING.

By S N. DEXTER NORTH.

THE card, and all the machinery preliminary or complementary to its work, are of later development than the inventions for mechanical spinning, which created the necessity for improved methods of carding. The evolution of the spindle is the central point in this development. The spinning of wool with distaff and spindle was the only method known until 1530, when one Jurgens, a baker of Brunswick, invented the one-thread spinning-wheel. A similar instrument was in use in India long anterior to this date, but Europe knew it no earlier. This wheel remained in common use until it was superseded by the spinning-frame. But it was improved a century later by the addition of a second bobbin, the invention of M. Besnière, so that both hands could be used in spinning, and the product nearly doubled at the same cost for labor.

The spinsters were wonderfully clever with this wheel, and performed feats which machinery can not surpass. The transactions of the British Royal Society have immortalized a Norfolk lady, Mary Pingle by name, by recording her achievement of spinning a pound of wool into 84,000 yards (nearly forty-eight miles) of yarn; and Mr. Vickerman vouches for the statement that a Lincolnshire spinster, named Ives, spun a pound of wool into 168,000 yards (95½ miles) on a one-thread wheel. The ordinary spinsters of the period reached 13,000 yards in coarse yarns, and 39,000 yards in the superfine qualities.*

* Charles Vickerman, lecture on The Woolen Thread.

The first attempts at the mechanical spinning of wool were made at about the same time in France and England. We read of a machine experimentally tried at Dolphin Holme in 1784, but success did not come until 1791. In 1780 the French Government gave three thousand livres to an Englishman named Price for the invention of a machine suitable for spinning combed wool.

FIG. 10.—A WOOL SPINNING-WHEEL. A, hand-cards; B, bobbin of roving.

Toward the close of the century M. Simonis, of Verviers, built a machine, by the aid of which three persons could spin four hundred hanks of yarn per day. The English succeeded about the same time in spinning combed wool upon one of Arkwright's machines.

The latter half of the eighteenth century witnessed the parturition of automatic textile manufacture. Invention seemed to suddenly awake from a lethargy of thousands of years. One labor-saving machine followed another with astonishing rapidity. The inventions of Kay, Hargreaves, Crompton, Arkwright, Watt, Cartwright, and a host of others, almost contemporaneous in point of time and general adoption, effected a revolution in every branch of textile manufacture such as had not occurred in all previous time, and whose like we can not again expect to witness. No other fifty years in the world's history are comparable with that half-century in their contribution to the world's capacity for

the production of the people's clothing. The automatic manufacture of wool received an impetus during these years so prodigious that we are filled with wonder and astonishment as we record the successive steps in the evolution.

Richard Arkwright has been called the father of the modern textile industry. This unique fame has securely and justly fallen to the humble barber who earned fortune, knighthood, and immortality by the keen, practical insight which combined, utilized, and perfected the inventions of others. The genesis of automatic textile machinery was before his advent, however, and he was the adapter rather than the inventor of the spinning-frame. In 1738 John Wyatt, of Birmingham, a man of education and ingenuity, worked out what he termed a "spinning-engine without hands," a machine subsequently improved and patented by Lewis Paul. Probably the two men shared the honor of the invention between them, while Paul obtained subsequent patents for spinning. In the specifications attached to Paul's application for a patent, the art of spinning by means of rollers was described for the first time. The cotton or wool being prepared in a rope or sliver of equal thickness, "one end of the sliver"—so read his specifications—"is put between a pair of rollers, or cylinders, or some such movement, which, being turned round by their motion, draw in the raw mass of wool or cotton to be spun in proportion to the velocity given to the rollers. As the sliver passes regularly through or betwixt these rollers, a succession of other rollers, moving proportionately faster than the first, draw the sliver into any degree of fineness that may be required."

These rollers are the mechanical substitutes for the thumb and finger. The Rev. John Dyer, in his poem on The Fleece, describes in rhyme the operation of the machine, and our readers may contrast this process with the distaff-spinning described by Catullus in the similar meter already quoted:

> "A circular machine, of new design,
> In conic shape: it draws and spins a thread
> Without the tedious toil of needless hands.
> A wheel, invisible, beneath the floor,
> To ev'ry member of th' harmonious frame
> Gives necessary motion. One, intent,
> O'erlooks the work; the carded wool, he says,
> Is smoothly lapp'd around those cylinders,
> Which, gently turning, yield it to yon cirque
> Of upright spindles, which, with rapid whirl,
> Spin out in long extent, an even twine."

About 1764 James Hargreaves, of Lancaster County, devised an ingenious and practical method of mechanical spinning, without the use of drawing rollers, which he called the spinning

jenny, and by which eight yarns or threads could be as easily spun as one. It was eventually perfected to such a degree that a child could keep eighty or one hundred spindles in motion. This machine was used to a limited extent in the wool manufacture, before it was superseded by the throstle of Arkwright and the mule of Crompton.

It is the common understanding that the woolen manufacture owes its development to the application of mechanical ideas first applied to the manipulation of cotton. The two industries have,

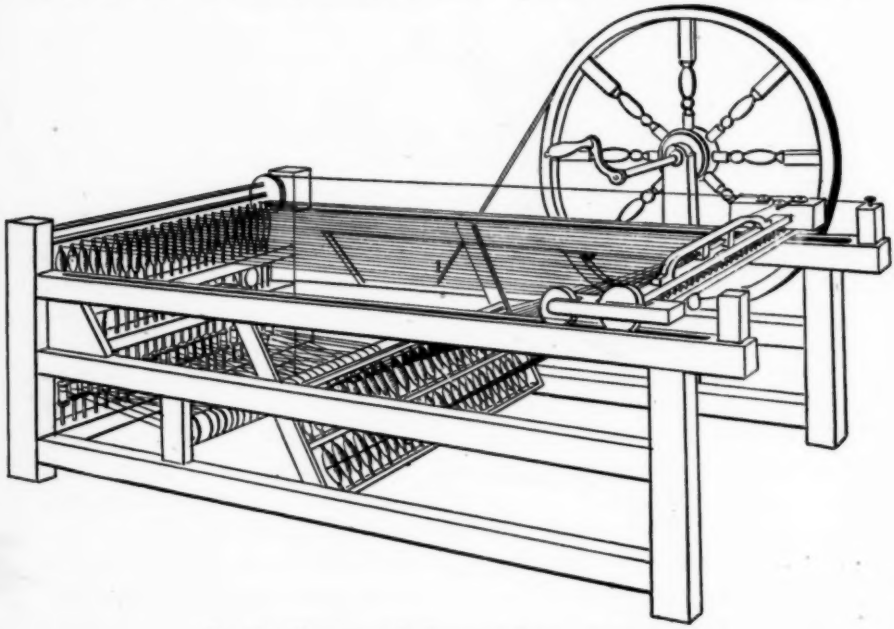


FIG. 11.—HARGREAVES'S SPINNING JENNY, AS IMPROVED.

indeed, marched forward shoulder to shoulder. They are allies, both in use and in methods of manipulation. Nearly every new idea in the mechanism of one has been turned to good account in the other. Cards for the combing of cotton were first adapted from the woolen manufacture, while on the other hand the woolen manufacture owes a vast debt to men whose discoveries were first applied to cotton. This debt is reciprocal, and it is hard to strike a balance of obligation. It was not until after Arkwright had utilized and developed Paul's machine for "spinning without fingers" that the wool manufacture began to get the full benefit of it. Arkwright's first patent was dated July 3, 1769; it covered the use of successive pairs of rollers drawing the sliver of cotton from one pair of rollers on to another pair running at greater speed, twisting the thread in the mean time by means of wooden fliers, with wire arms for correctly guiding the thread upon the

bobbins, and driving the latter by worsted bands. It is worth noting that James Watt obtained his first patent on the steam-engine in this same memorable year 1769. Thus the indispensable auxiliary of manufacturing evolution—the power to drive the machines that were to supersede the hands—had a contemporaneous birth. Long prior to the application of steam-power other agencies than human strength were utilized to drive these primitive machines. We read of asses harnessed to them, and Arkwright drove his first spinning machines with the aid of a bull. The English manufacturers were never able to utilize water-power for driving their machinery to the extent that it was applied in the earlier manufactures of the United States. The streams of New England were long the only motive power of her machinery; and their value to-day, in the various processes of the woolen manufacture, is beyond calculation.

Paul and Wyatt taught the world how to spin a hundred or more threads at one operation; but years elapsed after these early inventions before they came into general use. Paul worked his own machines for many years; but when he died they were broken up and sold, and the world continued to spin on the foot-wheel. The tardy realization of the value of these inventions was due primarily to the opposition of the hand operatives to the introduction of anything in the nature of improved machinery. The guilds were strong, and determined in their refusal to operate or tolerate new devices for dispensing with hand labor. Poor John Kay, after inventing his fly-shuttle, was compelled to close his mill at Leeds by the riotous hostility of the hand-weavers. Learning that he was also engaged in devising machinery for spinning, a mob broke into his house, destroyed everything it contained, and would have killed the inventor himself had not friends smuggled him away in a wool-sheet. We need not be surprised at the blind brutality of these ignorant workingmen. They looked upon the inventor as an enemy, planning to take the bread from their mouths. But what shall we say of the manufacturers who stole the patents of Kay, without recognition of the service his genius had done them? And what shall we say of the Government which permitted this man, in his old age, without recompense for inventions which added untold millions to the wealth of his country, to seek refuge from persecution in France, there to die in abject penury?

It needed a man of the determination of Richard Arkwright to force the world to appreciate the opportunity which these inventions opened before it. In 1775 Arkwright obtained a patent, the specifications of which contained the drawing rollers patented by Lewis Paul in 1738; the roving-can used by Benjamin Buller in 1759; the main cylinder and the finishing cylinder, both used

by Thomas Wood in 1774; the crank for working the doffer comb, invented by James Hargreaves in 1772; and a feeder, or cloth for feeding the carding engine, invented by John Lees in 1772.* That Arkwright covered other people's inventions in his patent was officially determined; but of his immense service to the world in teaching it how to utilize the inventions of others, and by their combination and improvement, there can be no doubt. He sought and found capital, keen enough to see the possibilities hidden in crude and isolated inventions. More than twelve thousand pounds had been expended in his mills before any profits were realized. But when profits once began they came fast, and here was made the first of the colossal fortunes which the manipulation of cotton and wool has brought to Great Britain.

Samuel Crompton, the inventor of mule-spinning, had a different experience from Arkwright, although he contributed quite as much to the mechanical evolution of the textile industries. His first mule, invented about 1779, carried forty-eight spindles on a movable carriage, the spindles turning on their axes and centers, while the movable carriage was receding from the rollers, which measured out the roving to a certain length. Two pairs of rollers were used, made of wood and covered with sheepskin, having an axis of iron. One pair revolved at a greater speed than the other, thus producing a draught or elongation of three or four inches to one. The carriage with the spindles could, by the movement of the hand and knee, recede just as the rollers delivered out the elongated thread in a soft state, so that it would allow of a considerable stretch before the thread had to encounter the stretch of winding on the spindle. Crompton thus adopted the system of spinning by rollers, wedded it to the useful jenny of poor Hargreaves, and endowed that union with the spindle-carriage, which was the crowning merit of his invention. Crompton's mule increased the power of a spinner a hundred-fold.

In this machine was first accomplished the automatic mechanical action of the spinner's left arm and forefinger and thumb, which held and elongated the sliver as the spindle was twisting it into yarn. It produced a yarn of much greater fineness and evenness than it had been possible to make by any process previously in use. This invention was the prototype of the mule, thousands of which are at work throughout the world to-day. It got this name from its combination of Paul's and Hargreaves's inventions.

The Crompton machine was correct in principle, but a rude piece of workmanship, dependent in all its original movements upon manual labor. Water was first applied to it as a motive

* Bennet Woodcroft.

power in 1790, by William Kelly, of Scotland. It was not until 1825 that the self-acting mule was evolved by Richard Roberts. His second patent, dated in 1832, made the self-acting mule applicable to the wool manufacture. But its use continued to be confined, for years afterward, almost wholly to the cotton manufacture. In almost all the American woolen-mills, down to the close of the civil war, the spinning continued to be done on the hand-jack, which is still found in many of them. The introduction of the automatic mule, which became general about 1870, has enormously facilitated the manufacture. It is stated by careful manufacturers that the substitution of the automatic mule, with the other improved machinery which has come during the same period, has resulted in a gain of fully thirty per cent. in production in twenty years. The economical gain, in the saving of help, is even more striking. Experts have calculated the difference between hand-jacks and mules in the cost of manufacture, as follows: Forty-eight cents for one hundred run yarn, with the jack; twenty cents for the same yarn, with the mule, or less than one half.

The hand-jack usually carries 240 spindles, revolving from 4,000 to 4,500 times a minute. Mules carry 300 or more spindles. In the organization of a woolen-mill one set of cards, which requires about twenty-six horse-power to run, will keep from 400 to 500 spindles in motion, although this relationship varies greatly, according to the class of goods manufactured, the age of the machinery, and the capacity of superintendents. American woolen-mills run, in their equipment, all the way from one to seventy sets of cards, and from 240 to 25,000 spindles.

In the woolen manufacture proper, as now conducted, there is but one process after that of carding and condensing to the perfect yarn, ready for the loom. The condensed sliver which has come from the cards is in fact a sort of yarn, which requires only twist and elongation to impart strength, firmness, solidity, and to reduce it to the proper size. The mule has two distinct motions which effect elongation and twist simultaneously. The carriage travels backward and forward, and carries the spindles which hold the bobbins on which the sliver has been wound, while in the frame are fixed other bobbins, called condenser bobbins, to receive the yarn. The machine in operation gives out from small rollers, fixed in the frame, a certain amount of the sliver, simultaneously with the imparting of a degree of twist; then the rollers cease to revolve, while the carriage continues to recede, drawing out the sliver to the necessary length, while in the mean time the spindles, revolving with an increased velocity, furnish what is called the finishing twist. The rollers limit the length of sliver to be operated upon, the carriage draws it, and the spindles impart the twist. This is a very general description of one of the

most complicated and beautiful processes in the whole manufacture, performed upon a machine which the operatives in some parts of Europe call "the iron man," in allusion to its deft action.

The mule is the machine now universally used in the manufacture of woolen yarn. But an entirely different method of

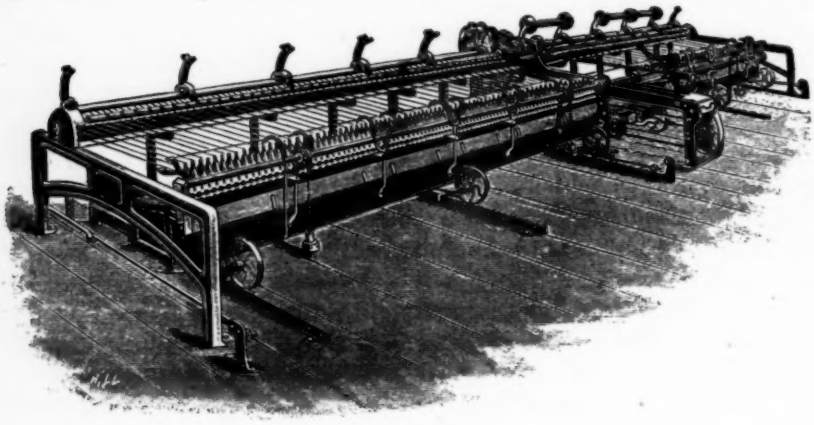


FIG. 12.—A WOOLEN MULE.

spinning is also applied in the woolen manufacture, or in that branch of it known as the worsted manufacture, quite distinct in several of its preliminary details, and quite as important in the modern development of the industry.

These two distinct processes of manufacture which have grown up in the treatment of wool, have practically made two industries out of one. They are alike, in that they utilize the same raw material, and do not essentially differ until the process of carding is completed. This diversion of the industry is traced to the immigration of the Flemings, which occurred during the reign of Henry I, although historians have attempted to antedate the worsted manufacture even to the Saxon period. The worsted manufacture originated at Worsted, a town in Norfolk, where one of the early Flemish colonies existed whose people employed a method of their own in treating the wool, which produced a woolen stuff of a peculiar quality, to which the name of worsted was given.* There is no earlier record of its existence than the time of Edward II (1315), when a complaint was made to Parliament that the clothiers of Norwich who manufactured worsted

* It is curious to observe how names have been inherited in the wool manufacture. Worsted is so called from the town where this particular method of manufacture originated. "Hank" is derived from the name Hankemus de Brabant, a Flemish spinner who settled in York; and "blanket" from the name of three brothers Blanket, also Flemish, who settled, at Bristol, among the immigrants tempted to England by the liberal inducements of Edward III.

were making pieces only twenty-five yards long and selling them as thirty (the regulation length).

Instead of simply carding the wool, the Flemish combed it. The hand-comber employed two combs—one as a "pad" comb, which was fixed to a post by an iron rod. The raw material, after being properly prepared, washed, oiled, and separated into convenient handfuls, was lashed into the comb upon the pad. Thus loaded with wool, the comb was placed in a stove adapted to the purpose and called the comb-pot, and when properly heated, one comb upon the post, the other held in the hand, the process of combing began, each comb becoming a working comb alternately, the teeth of one passing through the tuft of wool upon the other, until the fibers became perfectly smooth, straight, and free of short wool, or "noil," which was left imbedded in the comb-heads—the residue being called the "top."* The illustration shows how the hand-comb differed from the card used in the preparation of the wool for the woolen yarn.

FIG. 13.—A PAIR OF HAND-COMBS.

The material when thus combed differed from the same material carded, in that the combed wool contained only the long fibers, which lay parallel, the short fibers or noil having been altogether rejected or combed out. The carding eliminates no noil. Long and short fibers go together to the spindle. Thus it happens that a woolen yarn is soft and fluffy, while a worsted yarn is hard and firm, possessing a much greater tensile strength. In the woolen yarn the fibers are tangled and crossed, and drawing is avoided as much as possible in preparing the raw material for spinning, so as to leave the natural curvature of the fibers undisturbed and afford the greatest freedom of action to the felting quality of the wool. In worsted yarns the object is to obliterate the felting

* The origin of the word "top" is attributed to the fact that the product of the hand-comber was wound by him into a ball which took on a shape quite like that of a boy's top—large above, and tapering nearly to a point. The origin of the word "noil" is not as satisfactorily explained. Vickerman says that the term is from the Latin, and means "knotty," or "not do"; but this is at least doubtful.

quality and to secure elongation and parallel arrangement of the fibers."

In the early days of the manufacture the best results were only attainable in worsted yarns from long-fibered fleece. The English wools are commonly called combing-wools for this reason, and it was the possession of this fleece of an unrivaled quality which made England the birthplace of the worsted manufacture, and has kept it at the front in this process.

One of the results of improved machinery has been to remove any distinction between woolens and worsteds based upon the difference between the wools employed in the two processes. Short wool of merino blood can now be combed as successfully as the longer staple. The processes of treatment, however, continue to differ radically. This difference, as already seen, is primarily created by the introduction of the combing machine, an instrument unknown to the wool manufacture proper.

Short-stapled wool is carded before going to the comb; but the long wools, to avoid the breaking of the fibers which would result from carding, are prepared for combing by screw gill-boxes, so constructed as to open, separate, and straighten the fibers. Five or six slivers obtained from the first gill-box may be run into one by the use of a second gilling machine, so intermingling them that the deficiencies of one sliver are supplied by its neighbor. The half-dozen slivers are thus drawn into one smaller than any of those of which it is composed. This operation is continued through other gill-boxes when fine counts of yarn are desired, until the fibers have become thoroughly separated and parallel, to facilitate the work of the combing machine.

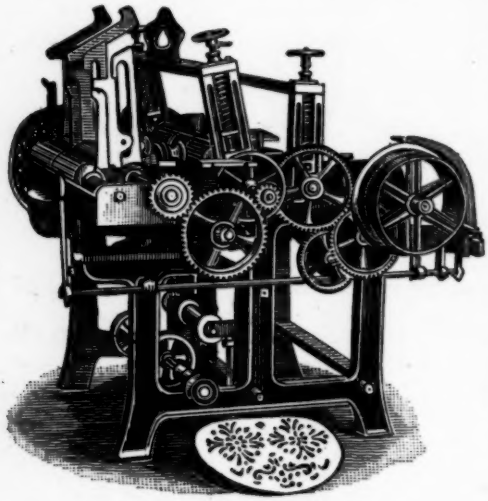


FIG. 14.—A GILLING MACHINE.

This machine is the mechanical wonder of the wool industry. It performs with automatic precision a series of complicated movements long deemed to be only capable of accomplishment by hands guided by human intelligence. For years after the idea of the machine took germ, it was the hope and the despair of many inventors in England and on the Continent. The hand-worker remained in exclusive control of the delicate operation until 1830.

Human intelligence required for the successful performance of combing expertness and experience in high combination. Woolcombers came to be a class by themselves in England—a class magnifying its own importance and skill—quite the aristocracy of the manufacture. For years after the experiments of the inventors were well under way, and even after machines were in

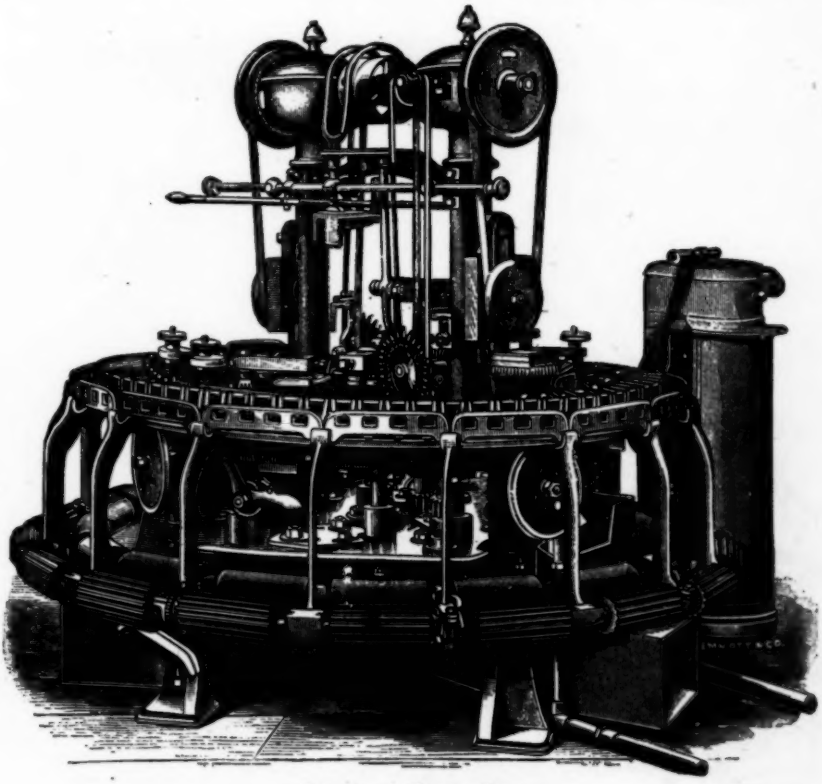


FIG. 15.—A NOBLE COMB.

actual use, the hand-combers remained confident that no automatic machine could supersede their boasted expertness of hand. Failure after failure seemed to warrant their confidence. The combing machine is one in which the power of the capitalist, no less than the genius of the inventor, has been exemplified. It cost more to complete, and has yielded more in the way of profit to its inventors, than any other machine of the century. To Dr. Edmund Cartwright, the inventor of the power-loom, belongs the honor of creating the germ of the subsequent machines. His first machine, patented in 1789, consisted of a cylinder, armed with rows of teeth, revolving in such a manner that its teeth would catch and clear out the wool contained in the teeth of a fixed and upright comb. His second machine, patented in 1790, superseded

this imperfect movement by the contrivance of a circular horizontal comb-table. The machine attracted great attention, and the wool-combers, of whom there were 50,000 in England, immediately petitioned Parliament for its suppression. A bill for that purpose was actually introduced in the Commons. As years passed with-

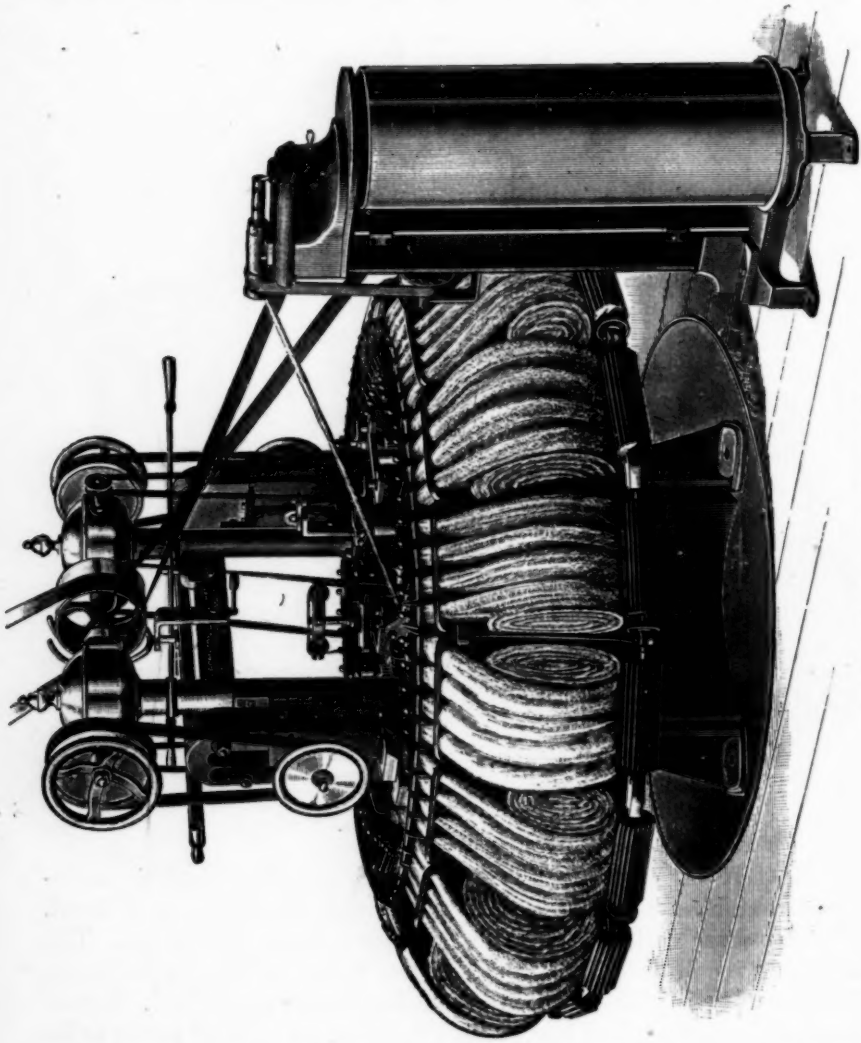


FIG. 16.—AN AMERICAN COMBING MACHINE.

out the successful application of the machine, they grew confident, and their annual celebrations of the anniversary of St. Blaize—the patron saint of the wool-comber—became largely demonstrations of defiance to the inventors.

Controversy will always exist as to who first evolved a successful combing machine. The names of George Edmund Donisthorpe, Samuel Cunliffe Lister, James Noble, and Isaac Holden

are equally associated with the evolution of the machine in England; while that of Josue Heilmann, an Alsatian, who undoubtedly worked out a combing machine on independent lines, is immortalized by his invention, which was patented in France in 1845, and in England in 1846.

The various inventors named created three machines, working upon different principles, all of which are now in use, and each of which has points of superiority in different kinds of work. They are known as the Lister, the Noble, and the square-motion combs; the French machine, founded upon Heilmann's invention, being a modification of the Lister. In 1843 Mr. Lister succeeded in combing the first fine wool (Botany) ever combed by machinery. After that the use of the machines speedily became general. The Noble comb is in the most common use, perhaps, being found superior for combing the short-stapled wools now largely utilized in the worsted manufacture. The Lister machine is preferred for the long-stapled wools. The picture of the Noble comb conveys a good impression of its general appearance. An intelligible description of its complicated and delicate parts is out of place in a paper of this description. Only when seen in operation can one truly appreciate what a wonderful achievement of the human mind is the combing machine.

From the comb, the wool intended for worsted yarn, now in the form known as "tops," goes first to a back-washing machine, to eliminate any remaining dirt, and is again gilled. The introduction of the gill-box, or drawing machine, now effects another distinction between the worsted and the woolen yarn. It is the beginning of a process of drawing, which continues through many subsequent machines. The worsted yarn is the result of a series of combinations or doublings accompanied by drawing or stretching. The drawing machine combines and reduces the thick sliver, or a number of them, down to a size so small that it can be spun into a thread without an excessive draft, and at the same time levels it so that the thread will be of uniform thickness. The sliver is put through six or more machines, each of which combines and draws half a dozen larger slivers—more or less according to the size of the yarn to be spun. Thus, in a Botany wool, with nine operations, the number of slivers ordinarily combined are 8, 6, 5, 5, 5, 4, 3, 2, 2, which are equal to the enormous number of 288,000 doublings. There have been at least two doubling operations between the comb and the top, of say ten and six slivers in each case, so that the total doublings from the comb to the spindle amount to 17,280,000. By this process of continued doubling and drawing, it becomes an easy matter to spin worsted yarns of extreme fineness, running in their counts all the way up to 80s, 90s, and even higher, the French particularly

excelling in the manufacture of very fine counts, to which their system of worsted mule-spinning seems to be especially adapted. The finer yarns spun in America will usually average about 40s, which involves a length of more than 20,000 yards to a pound of yarn.

From the drawing machines, the material next advances to the roving frame, the last operation through which the sliver—called "slubbing" at this stage of manipulation—must pass before it is ready for spinning. Roving may be described as a combination of drawing and twisting, with an excess of drawing; while worsted spinning is a combination of the same processes, with an excess of twisting.

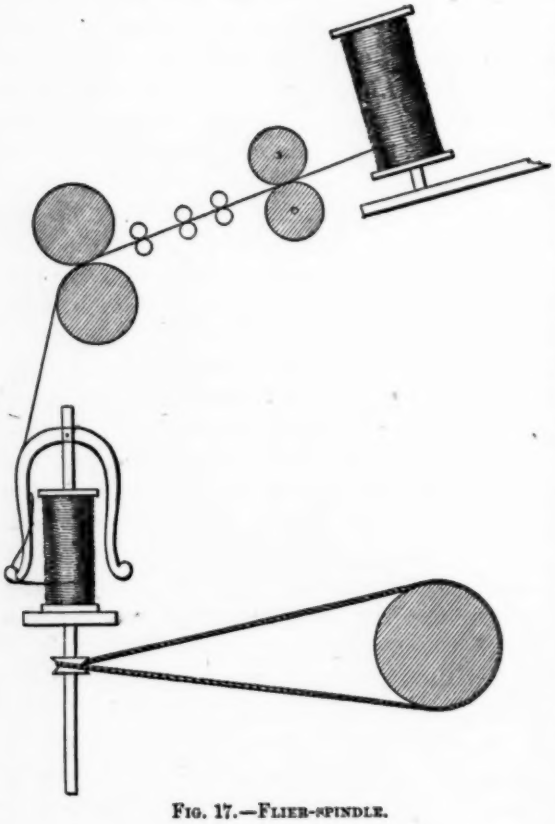


FIG. 17.—FLIER-SPINDLE.

The spinning-frame, originally used in the worsted manufacture, is very different from the mule, the roving having been subjected, as we have seen, to processes not required in dealing with the condensed sliver. In the worsted spinning-frame, or throstle, the rollers are so arranged as to draw out the roving before any twist is imparted. There are three distinct types of worsted spinning-frames in common use, known as the flier, cap, and ring. The French utilize a fourth method, involving a different preparation of the roving, which is simply the principle of mule-spinning, already described. A flier-spindle is shown in the illustration.* It is most commonly used for the

* It is quite clear that the flier, which is fitted around modern spindles for twisting the yarn before it is wound on the bobbin, was known to Leonardo da Vinci, and probably invented by him. Among his mechanical drawings is one which shows a spindle, with flier and bobbin, with a device for moving the bobbin up and down on the spindle so as to effect

lower counts of yarns. The flier-spindle has a rotary motion. In cap-spinning (see illustration) the spindle and the cap are the stationary parts. A tube or shell, which receives the bobbin, is placed on the spindle, and its motion distributes the yarn upon the spindle. Cap-spinning is chiefly utilized in the finer counts of yarn, as there is no limit to the speed at which the bobbins may be made to revolve. In ring-spinning, which is more common in the cotton manufacture, the spindles revolve, and the bobbins are so attached as to revolve with them, thus imparting their own twist. The ring-frame is more largely used in the worsted-yarn manufacture for doubling, or making twofold yarns, than for spinning.

FIG. 18.—CAP-SPINDLE.

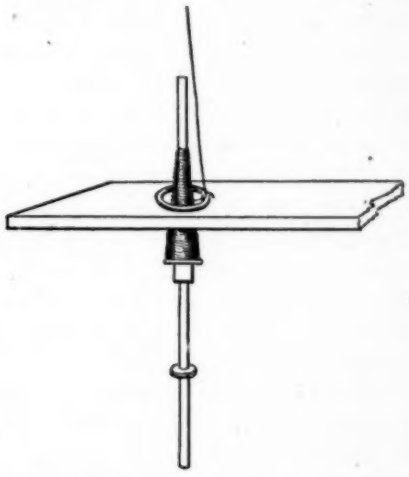


FIG. 19.—RING-SPINDLE.

It may now be easier for the reader to fully comprehend the difference between a woolen and a worsted thread—made from the same wool in many instances, but so differently treated in manipulation that they seem almost as fundamentally unlike as a woolen and a cotton thread. Worsted has received a treatment similar in many respects to that by which a cotton thread is made. We have seen that the worsted manufacture is a series of processes continuously following each other, and that the woolen manufacture is a compound process intermittently carried on. The woolen sliver, after leaving the carding machine, is wound at once upon bobbins attached to the mule. In this machine the spindles have a compound motion, simultaneously in progress, whereby the sliver is drawn and wound. This operation completes the woolen thread. This yarn requires very different treatment, both in the weave and the finish, from the worsted yarn. The latter is distinguished by a compact weave, ready at

an even distribution of the yarn. But the use of the flier was not known in England before the end of the seventeenth century. In a pamphlet printed in 1681, by Thomas Firmin, there is an illustration of an improved wheel, with two spindles, provided with fliers, having on them hooks or pins for directing the yarn on different parts of the bobbin.—*Encyclopædia Britannica.*

once for the finishing. The woolen fabric comes from the loom loose, open, rough, and must be thoroughly milled or fulled before it is finished.

The woolen cloth—spun on the mule, and milled—was, until a few years back, the only wool fabric made for men's wear. There are innumerable varieties of it, including broadcloths, doeskins, twills, flannels, tricots, beavers, cassimeres, cheviots, meltons—trade-names which stand for certain standard fabrics, with little regard for their etymological significance. Until the year 1840 the wool manufacture of the United States was exclusively confined to the woolen form. In that year the first delaines made in this country were manufactured at a mill in Ballardvale, Mass. All the wool was combed by hand, and the printing of the goods was at first also by hand. The success of this experiment started others in the field, and by 1855 several of the largest establishments in the country were engaged in the manufacture of ladies' worsted dress goods.

The use of the worsted process in garments for men's wear is as recent as the year 1866. It appears to have originated in England, where Josiah Lodge, of Huddlesfield, claims to have been the first to utilize the process in the manufacture of men's trouserings and suitings. The innovation was quickly adopted in France, in Germany, and in the United States, and these worsted suitings are so popular and so serviceable that the manufacture of wool goods may almost be said to have been revolutionized in the interval. There are to-day as many persons and looms employed in the worsted manufacture in England as in the woolen manufacture, and the substitution of worsted for woolen machinery has been going on at a rapid rate. The largest wool manufacturing establishment in the world, that of Isaac Holden & Sons, at Bradford, England, contains three hundred sets of cards and three hundred combing machines, and is exclusively employed in the manufacture of "tops" for the worsted spinners. In this country our largest mills are engaged in spinning worsted yarns and weaving worsted cloths. In their equipment they run from two or three combs up to fifty or sixty, and from ten thousand to fifty thousand spindles. It is impossible to state a relationship between combs and spindles, owing to the great variety of the yarns and fabrics made from worsted. Although no radical improvements have recently been made in the comb, the efficiency has been increased about thirty per cent in the last twenty years. In 1870 the product of a comb was from four hundred to four hundred and fifty pounds a day. The same labor will now produce from seven hundred to eight hundred pounds, yielding a better quality of product.

The Evolution of Weaving.

The earlier improvements in spinning machinery which have been described, preceded, in point of time, the development of the loom, and thus made more conspicuous the primitive methods of weaving that continued in vogue, and became a stimulus to inventors in this field. Arkwright's machinery was even regarded as an evil, for a time, on the theory that it enabled England to spin more yarn than her weavers could fabricate, and the surplus, exported to the Continent, could there be woven into cloth so cheaply as to seriously injure English trade.

The strict chronological order of the initiative steps in the development of woolen machinery would have headed the list of the noble army of inventors with the name of John Kay. Kay had the management of a woolen factory at Colchester, England, belonging to his father. Having a sort of universal genius for mechanical invention, he introduced various improvements in dressing, batting, and carding machinery, as well as in the Dutch drawboy and inkle looms, that had been brought from abroad by his father. He also invented an improvement in reeds for looms, by making the dents of their polished blades of metal, instead of cane (the only materials used up to that time), by which they were not only rendered more durable, but adapted to the weaving of fabrics of a finer, stronger, and more even texture than cane reeds could produce. Kay secured patents for several of these improvements, which were universally adopted. But his crowning invention was the first fly-shuttle known to man, patented May 26, 1733. Hitherto the shuttle had been thrown back and forth between the warp threads, being thrown by one hand and caught by the other alternately, while each weft thread was driven home by the "layer," propelled by the hand which had just cast the shuttle. In broadcloths, the process differed in this, that a weaver stood upon either side of the work, and the shuttle was thrown alternately from one to the other. Thus for more than five thousand years, by millions of skilled workmen, one generation following in the exact footsteps of another, had the clothing of the people been woven, with little attempt to expedite or to simplify the process. Thus had been fabricated the mummy-cloth of Egypt, the "woolen wind" or fibrous muslins of the Indias, the rich tapestries of the Greeks and Romans, and every other fabric of every character and age.

John Kay's invention consisted of a race-board fixed to the "layer" under the warp, with a shuttle-box at each end, a spindle and picker in each box, and a cord passing from each picker to a short lever held in the weaver's right hand. These improvements did not dispense with the weaver's hands and feet in forming the

cloth, but they permitted one hand to be used exclusively in throwing the shuttle, while the other was solely occupied in driving home the weft. The comparative speed of fabrication, by reason of this invention, won for it the name of "fly-shuttle"; and in truth it is likely that no division of labor between the two hands of one operative ever produced results equal to those which this invention secured.

At once, upon its general adoption, the average production of a loom was more than doubled, and the cloth was of a better quality than formerly. The same shuttle arrangement, with hardly any change, appears in the looms upon which our grandmothers wove their homespun, and they may still occasionally be seen in the old farm-houses of the United States.

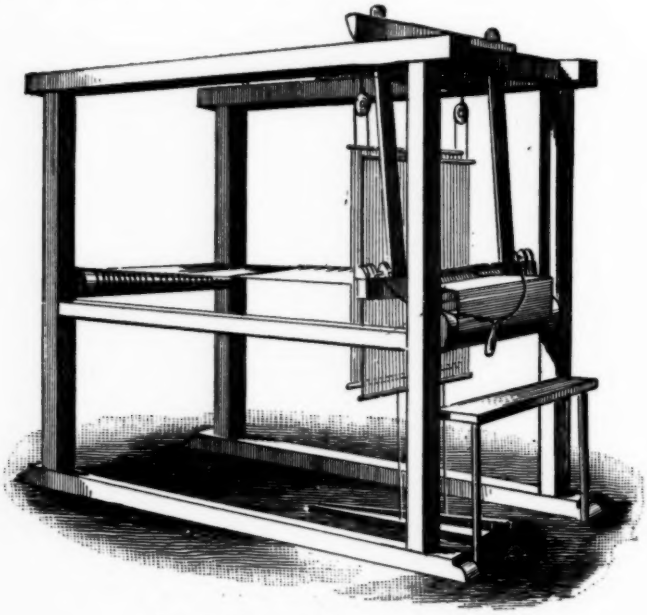


FIG. 20.—COMMON FLY-SHUTTLE LOOM.

As early as 1678 a French naval officer, M. de Gennes, conceived the idea of a power-loom, and communicated his plan to the French Academy. He described, prophetically, the advantages its utilization would effect in economy, in uniformity of product, and in increase of production—precisely as we have since realized them. More than a century elapsed before his ideas were successfully utilized. Numerous attempts were made, but through one defect or another they failed of adoption.

A studious clergyman, addicted more to poetry than to trade, led the way in the solution of this problem. His name was Edmund Cartwright, already alluded to in connection with the comb-

ing machine. He had never set foot inside a cotton or woolen mill at the time when he undertook to revolutionize their entire methods. A strange-looking and clumsy machine Cartwright's first power-loom was, according to his own description. "The warp," he wrote to a friend, "was placed perpendicularly, the reed fell with a force of at least half a hundred-weight, and the springs which threw the shuttle were strong enough to have thrown a Congreve rocket. It required the strength of two powerful men to work the machine at a slow rate, and only for a short time; but I succeeded in weaving by its aid a piece of coarse cloth like sail cloth. Conceiving, in my great simplicity, that I had accomplished all that was required, I then secured what I thought was a most valuable property, by a patent, on April 4, 1785. This being done, I then condescended to see how other people wove; and you will guess my astonishment when I compared their easy mode of operation with mine. Availing myself, however, of what I then saw, I made a loom in its general principles nearly as they are now made." The theologian, having learned what the weavers could tell him, taught them more than they had been able to teach themselves in a thousand years.

The principle and the working of the hand-loom and the power-loom of Dr. Cartwright were the same, and they continue to be the same throughout all the modifications of the perfected loom. Their three fundamental motions are, first, the "shedding," or dividing of the warp threads by means of harnesses, to permit the passage of the weft threads between them; second, the "picking" or shooting of the weft; and, third, the "battening" or beating home of the weft. In the first power-loom, Dr. Cartwright combined, with the frame, the beam, the heddles, and the harnesses of the hand-loom, mechanical substitutes for the weavers' hands and feet. They were tappets and treadles, for operating on the warp; apparatus for throwing the shuttle, driving home the weft, letting off the warp, taking up the cloth, stopping the loom on the breaking of a thread, and self-acting temples. The problem of weaving once solved, however crudely, improvements upon Dr. Cartwright's loom followed naturally. Dr. Jeffray, a Paisley physician, soon improved the Cartwright loom by introducing a device to prevent the breaking of the weft; and it was again improved by one Miller, of Dumbartonshire, who substituted for the spring, in throwing the shuttle, the direct action of the motive power. The splendid machines of to-day, doing their beautiful work so smoothly, so perfectly, so rapidly, have grown gradually, one improvement following another, out of the clumsy Cartwright machine so quaintly described above. It is a source of pride to American manufacturers that in this department also the contributions of American inventors have vastly advanced

the industry and have been recognized throughout the manufacturing world. Not only did two distinguished Americans, Francis C. Lowell and Patrick T. Jackson, practically reinvent the power-loom, in 1813, as applied to cotton goods, but another, an adopted citizen, William Crompton, first adapted the power-loom to the weaving of fancy woolen fabrics, and to-day the two principal

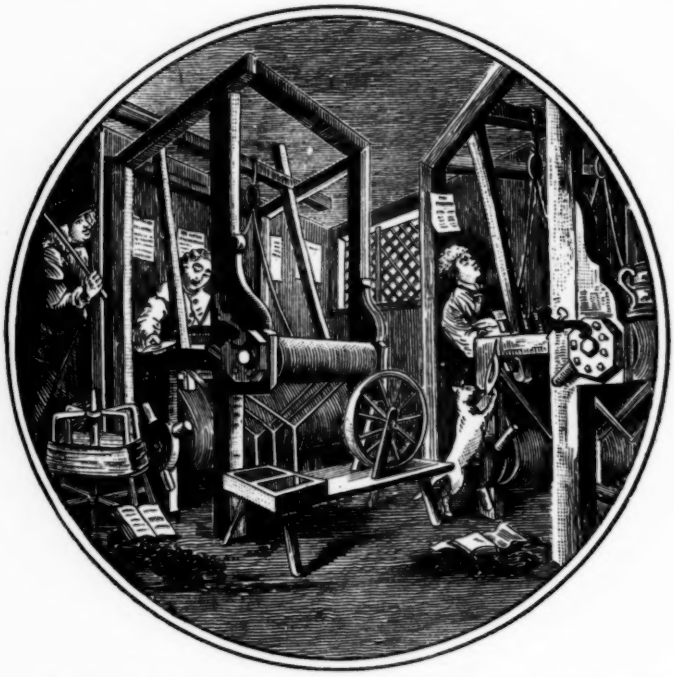


FIG. 21.—HAND-LOOM OF 1750. (From Hogarth's Two Apprentices.)

makes of American looms, the Crompton and the Knowles, are generally recognized as superior to any foreign patterns and are largely used in foreign mills.* Crompton's fancy power-loom was applied to woolen fabrics in 1840. "Not a yard of fancy woolen fabrics had ever been woven by a power-loom in any country," wrote Samuel Lawrence, "until it was done by William Crompton at the Middlesex Mills, in Lowell, in 1840." It was affirmed before a congressional committee in 1878 that "upon a Crompton loom, or looms based upon it, are woven every yard of fancy cloth in the world." The importance of this contribution to the wool manufacture can only be appreciated in connection with the fact that three quarters of all the woolen cloths now worn are woven upon fancy looms. Up to that time it had been

* Over eight thousand of the Knowles open-shed fancy looms are now in operation in England.

deemed impossible to successfully weave the finer worsted fabrics except by hand.

There is no machine of Crompton's first build known to be extant, nor even a picture of one. In 1855 it was greatly improved, and its capacity increased from eighty to ninety picks per minute. The illustration shows one of the narrow looms of the 1855 pattern, with its working parts well brought out. In 1857 the Cromp-

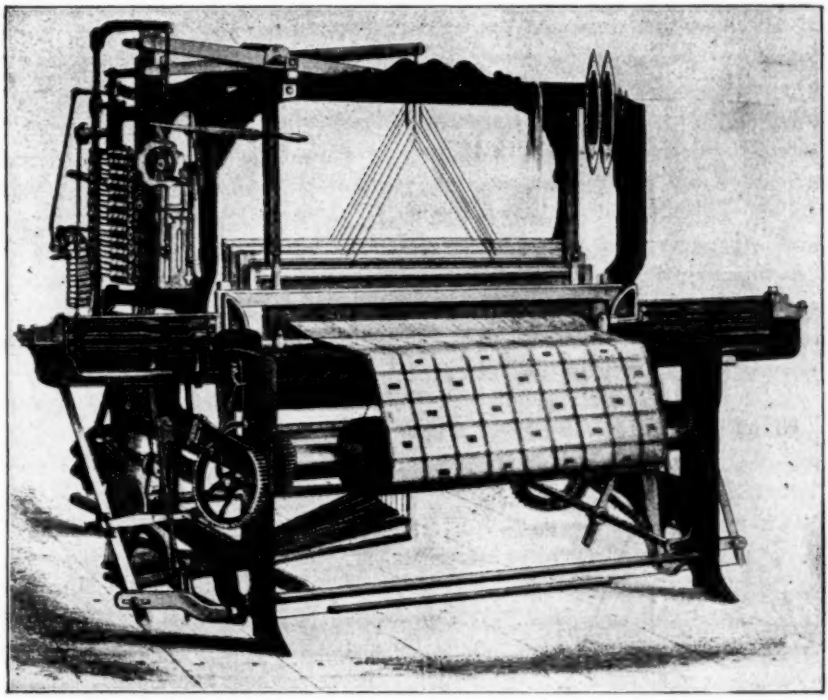


Fig. 22.—The Crompton Fancy Narrow Loom of 1855.

ton establishment perfected the pioneer broad loom, of which great numbers were made during the succeeding ten years. They were made ninety-two inches wide in the reed space, and attained a speed of eighty-five picks a minute with twenty-four harnesses, thus practically doubling the productive capacity of the operative, who could attend a broad loom as easily as a narrow loom. This machine was therefore an enormous stride in advance; none that has since been made can equal it.

Mechanical weaving has now reached a perfection that the hand-loom can not attain. There is greater regularity in the product, less waste of material, and great saving of labor—one weaver in the lighter fabrics easily attending to two or three looms. The power loom is worked without muscular effort, dexterity in the repairing of broken yarns being the chief require-

ment of the operatives. Consequently, women have almost universally superseded men in its operation.

I shall attempt no description of the power-loom, or of its complicated motions. The illustrations represent the most recent patterns of American broad looms for heavy worsteds, of twenty-five or thirty-six harness capacity, upon which can be woven every variety of fabrics, from the simplest to the most intricate. These looms can be arranged for the Jacquard attachment.

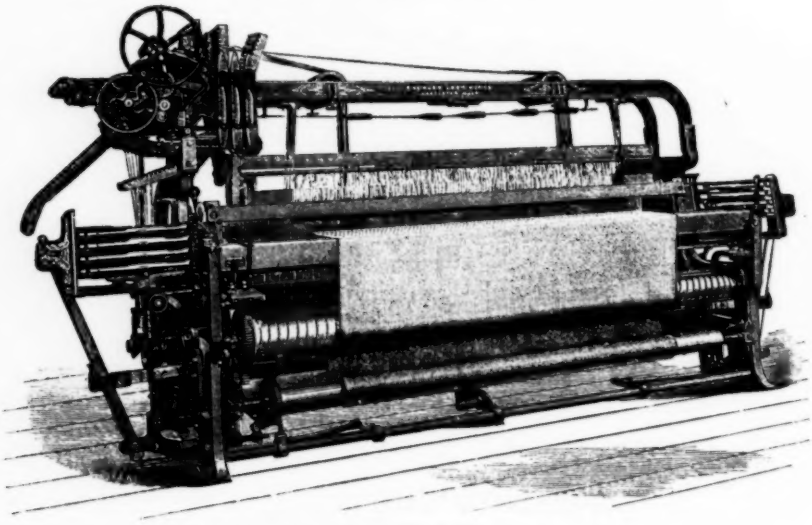


FIG. 23.—KNOWLES'S OPEN-SHED FANCY LOOM.

Remarkable success has attended the efforts to increase the speed of the power-loom. They are built to vary in speed from fifty-four to three hundred picks a minute, according to the fabric upon which they are employed. One hundred and fifteen picks a minute, for each one of which the shuttle travels one hundred and fifteen inches, is now accomplished in the weaving of fancy worsteds. This is not a single or simple motion, but a series, each dependent on the other. The power-loom, at one and the same time, forms the shed in the warp threads, as called for by the pattern or design, and, through the agency of few or many harnesses, propels the shuttles in consecutive order across the piece, beats the picks of weft into close compact, and winds the woven cloth on the piece-beam. Should the wet yarn break or run off the bobbin, or should the shuttles fail to reach home, the loom automatically stops itself. What more can human ingenuity do for the power-loom?

However improved, the principle of weaving is that utilized in the primitive hand-looms. No more complicated pattern or weave can now be made than the ancients achieved on their hand-looms.

Homer describes a product of Creusa's shuttle, in which appeared a gorgon and dragons. The damasks and tapestries of the ancients were as elaborate in figure-work, woven into the warp and woof, and more beautiful in coloring, than modern machinery has ever achieved. The famous Gobelin tapestries, with their elaborate allegorical scenes, present a development of the art impossible

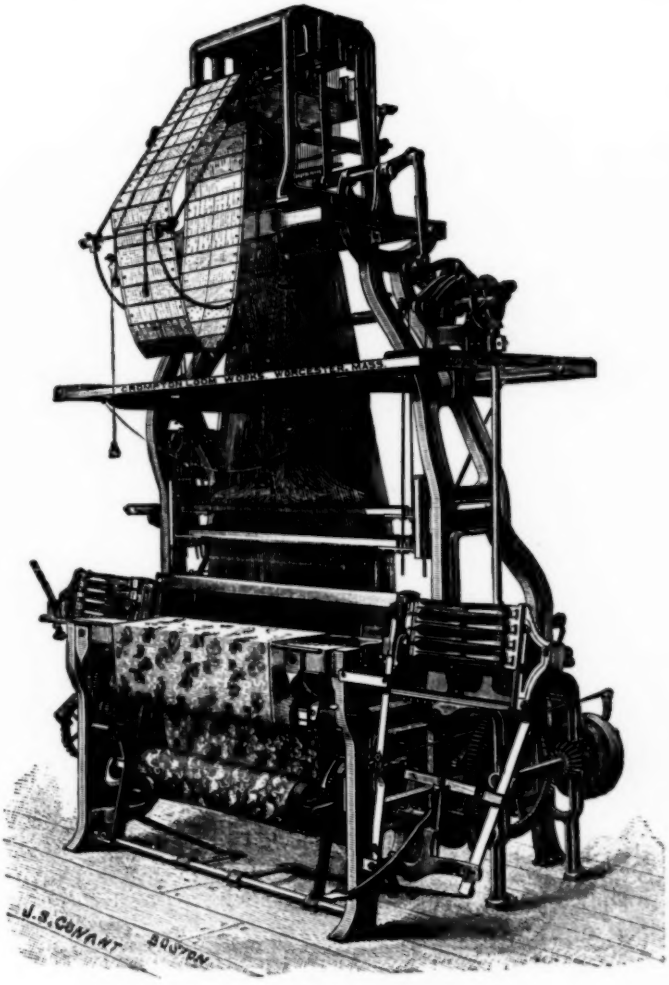


FIG. 24.—CARPET-LOOM, WITH JACQUARD ATTACHMENT.

to automatic machinery. Neither has machinery increased the number or variety of the weaves in common use. But a single invention, that of Joseph Marie Jacquard, and known by his name, has made possible in power weaving the making of figured patterns without limit of variation, thus robbing the hand-loom of one of its last points of superiority. Jacquard perfected his

invention in 1800, and its use has gradually become general in figured goods. It is regarded as the greatest invention in the art of weaving, next to the power-loom itself, and was only eclipsed by that of our own inventor, Erastus B. Bigelow, who made the Jacquard loom automatic. A report of the patent commissioner has declared that "Mr. Bigelow's invention presents a machine which is admitted to be unsurpassed by anything which the mechanical genius of man has ever devised." Mr. Bigelow's invention was patented in 1838, but not perfected for Brussels carpets until ten years later. It revolutionized that industry at once. The cost of weaving Brussels carpets had hitherto been about thirty cents a yard, and the product of the hand-loom did not exceed four yards a day. The Bigelow invention made it easy for a single female weaver to weave from twenty-five to thirty yards of carpet a day, at a cost for labor of about four cents a yard. With the expiration of Mr. Bigelow's patents a most extraordinary impetus was at once given to the carpet manufacture in the United States, where to-day more carpets are made and used than in any other country.

The power-loom, as to-day constructed and used, is unquestionably one of the most perfect, as it is one of the most complicated, of human inventions. The range of textiles, hitherto made only on hand-looms, is becoming, on account of the constant development of the power-loom, more limited every year. It is only in the production of fabrics in the weaving of which continual and elaborate changes have to be made in the colored weft threads that the hand-loom is still used—excluding, of course, its permanent use as a pattern-loom.

The development of the loom has been accompanied by many inventions which simplify and expedite loom-mounting, which includes all the processes through which the warp yarns must pass between the spinning-frame and the loom. Filling is wound directly into a cop for the shuttle, and placed therein, ready for the weaving. The processes to which warp yarns are subject are known as warping, sizing, beaming, healding, and sleying. They determine the character and variation of the weave; and, in a sense, the art of cloth manufacture, as distinguished from its mechanics, may be said to center in them, and in the designing-room, from which they are controlled. We have left ourselves no space in which to even allude to the various interesting and ingenious machines now utilized in the preparation of the warp for the loom. Necessarily this is the point in the manufacture of fancy goods where automatic machinery can not be wholly applied. In connection with the action of the harnesses in the loom, all the variations of the weave are determined by the designer, whose plans for the distribution and shedding of the threads must be carried out by hand.

The study of the weaves and of the possibilities of variation in fabrics, arising from the different methods of inserting the weft threads into those of the warp, from the use of different colored threads, both for warp and weft, and by the use of different materials, is perhaps the most fascinating branch of the whole

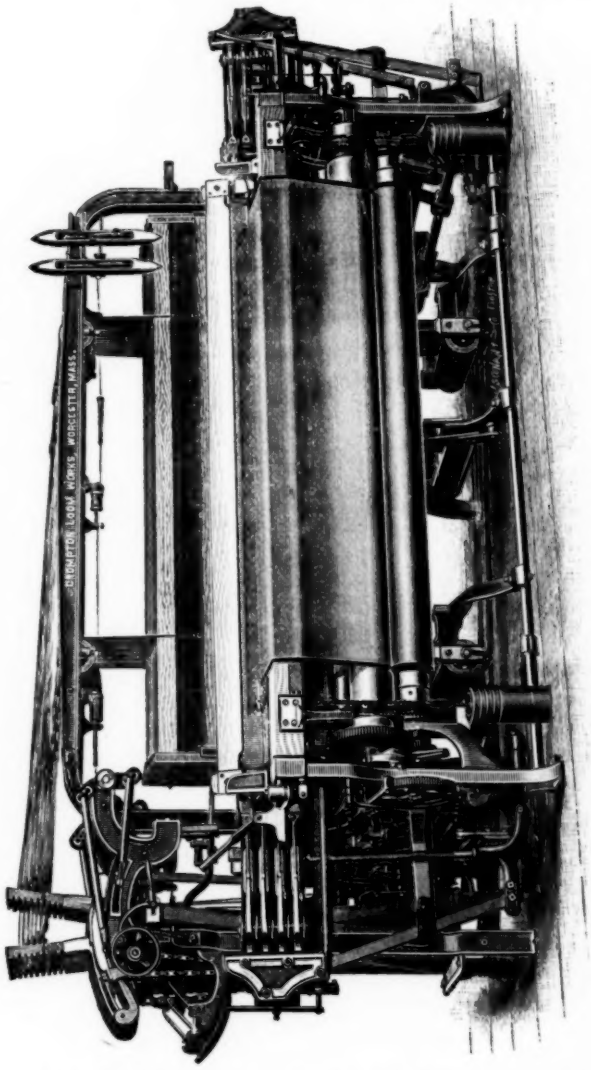


FIG. 25.—THE CROMPTON THIRTY-SIX HARNESS WORSTED LOOM.

textile industry. But it is out of place in a paper that relates to the mechanical evolution of that industry. Machinery has done more than its share to assist human ingenuity in the devising of new and attractive variations upon the fundamental weaves. A loom in which thirty-six harnesses can be worked automatically suggests variations of pattern which are practically infinite.

These looms, with the aid of the Jacquard attachment, have enlarged the field of art in woolen fabrics, so that it now presents a limitless opportunity for the play of genius. In this direction we may look for constant advances. In recognition of the opportunity, textile schools for the better education of those who have to do practically with the manufacture have been established in the chief manufacturing nations of the Continent and in England. The influence of these schools upon the character of woolen fabrics is increasingly perceptible and is most gratifying. It is this influence which to-day constitutes the chief advantage which foreign manufacturers possess over those of the United States in the woolen manufacture. Nor can we hope to equal their achievements in this country until we have supplied the means for the better technical education of those who determine the character of the fabrics made in the American mills. In machinery equipment, and in all appliances for economical production, our best mills are fully abreast of the best foreign mills. But in the character of our products we continue to be imitators rather than originators.

MAN AND THE GLACIAL PERIOD.*

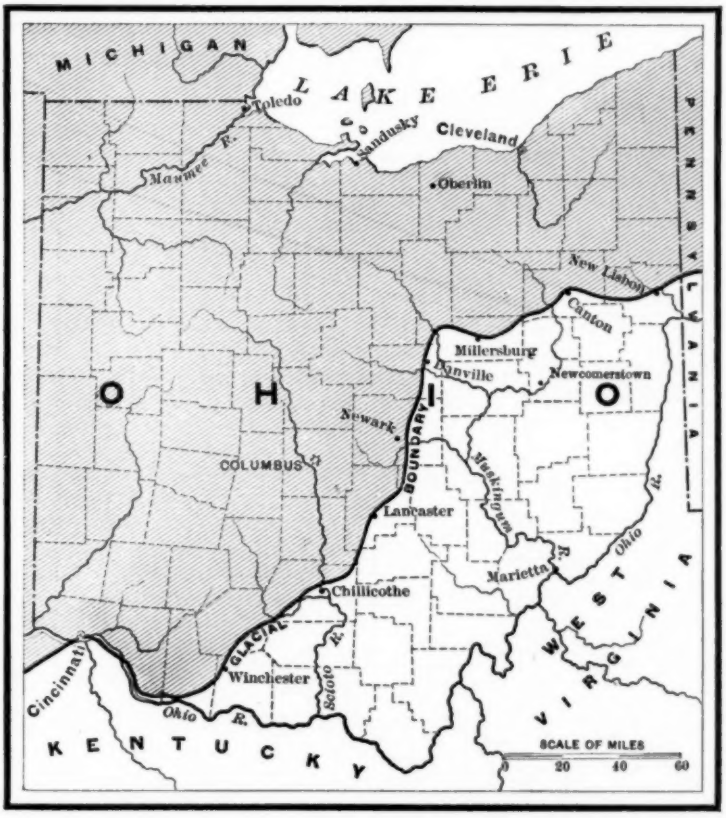
By Prof. G. FREDERICK WRIGHT.

SOME most important facts have come to light during the past two years bearing upon the connection of man with the Ice age in North America.

In October, 1889, Mr. W. C. Mills, president of a local archæological society of some importance at Newcomerstown, on the Tuscarawas River, in Ohio (see map), found a flint implement of palæolithic type fifteen feet below the surface of the glacial terrace bordering the valley at that place. The facts were noted by Mr. Mills in his memorandum-book at the time, and the implement was placed with others in his collection. But, as he was not familiar with implements of that type, and did not at the time know the significance of these gravel deposits, nothing was said about it until meeting me the following spring, when I was led from his account to suspect the importance of the discovery. Mr. Mills soon after sent the implement to me for examination, and its value at once became apparent. In company with Judge C. C. Baldwin and two or three other prominent citizens of Cleveland, I immediately visited Newcomerstown. A cut of the implement is given in the accompanying pages, made from a photograph one

* From supplementary notes to the new edition of The Ice Age in North America, and its Bearings on the Antiquity of Man. New York: D. Appleton & Co., 1891.

quarter the diameter. Beside it is a palæolith which came into my possession from Dr. Evans's collection in London, with his certification that it is from the valley of the Somme. The two implements, as they appear side by side, are in shape and finish the exact counterparts of each other. The one from Newcomerstown,



however, is made from a local flint which occurs in nodules in the "Lower Mercer" limestone, which is situated in the lower part of the coal-measures, and crops out a few miles from there.

The implement has upon it the patina characteristic of the genuine flint implements of great age in the valley of the Somme, and is recognized by Prof. Haynes, of Boston, as in itself fulfilling all the requirements looked for in such a discovery. The gravel-pit in which it was found is one which for some years has been resorted to by the railroads for ballast. Mr. Mills saw the implement as it was projecting from the undisturbed gravel in the fresh exposure, and took it out with his own hands. The surface of the glacial terrace is here thirty-five feet above the present high-water mark of the river, and, as already said, the implement was found fifteen feet below the surface. The terrace is one

which characterizes the Tuscarawas River everywhere below the glacial boundary. Additional interest is given to this discovery by the fact that it is from one of the valleys to which I had directed attention several years before as likely to yield such discoveries.

The other most important facts bearing on the antiquity of man come from the Pacific coast, and perhaps have only an indirect connection with the Glacial period; but as their connection

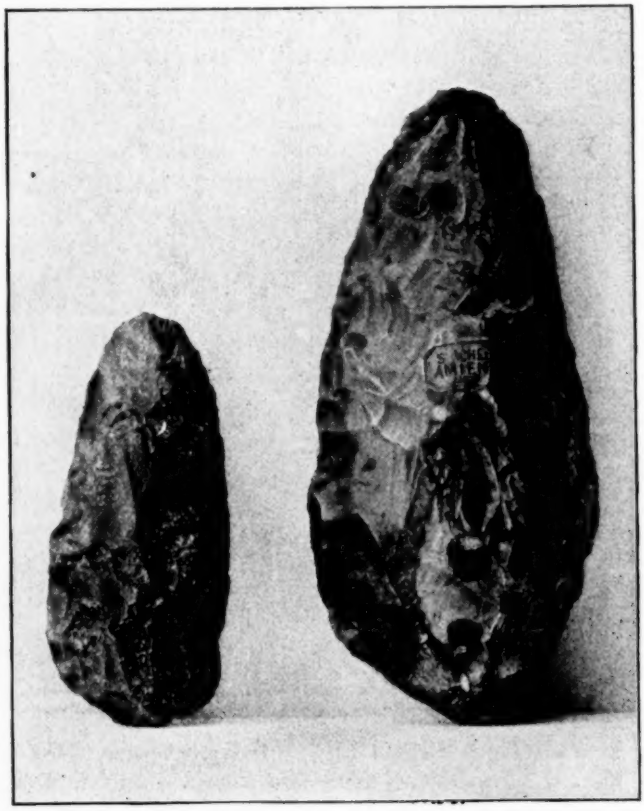


FIG. 1.—THE SMALLER IS THE PALÆOLITH FROM NEWCOMERSTOWN, THE LARGER FROM AMIENS (face view).

with the period must stand or fall with the facts collected some years ago by Prof. Whitney, I will allude to them here.

In the autumn of 1889, Mr. Charles Francis Adams, then President of the Union Pacific Railroad, brought to my notice a small clay image, an inch and a half in length, which had been found by Mr. M. A. Kurtz while boring an artesian well at Nampa, Ada County, Idaho. The image was of slightly baked clay, incrusted in part with a coating of red oxide of iron, which indicated considerable age, and came up in the sand-pump from a depth of three

hundred and twenty feet. Near the surface the well penetrated a stratum of basalt, fifteen feet thick. Below this basalt there were alternate beds of clay and quicksand to the depth mentioned, where the sandstone rock was encountered. The well was tubed with heavy iron tubing six inches in diameter, so that there could be no mistake about the occurrence of the image at the depth

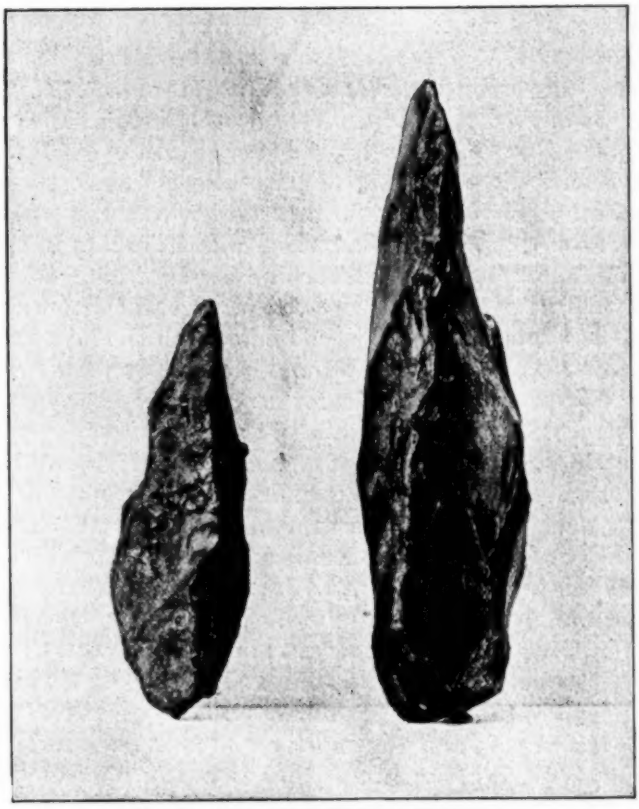


FIG. 2.—EDGE VIEW OF THE PRECEDING.

stated. The detailed evidence was published by me in the Proceedings of the Boston Society of Natural History for January, 1890. During this last summer, also, I visited the locality and found ample confirmation of it.

In the valley between the Boisé and Snake Rivers, in southwestern Idaho, where Nampa is situated, there is an area of several hundred square miles covered with fresh-appearing basalt, which apparently came from vents thirty or forty miles to the east, but in its western flow barely extended five miles beyond Nampa. Below that point there is no lava for seventy miles. The clay and quicksand covering the stratum in which the image was found would seem to have accumulated in the valley of a

stream having access to such an amount of sedimentary material that for a time it filled up rather than eroded its channel. Apparently the conditions favorable to such effects would be most readily furnished during the Glacial period, when the streams of that region were swollen not only with the increased annual precipitation, but with the melting of the glaciers which doubtless had for a long time occupied the mountains near the head-waters of the Boisé River to the north. Very likely, also, the lava-flows which obstructed the river a few miles above Boisé City turned its course to the southward, so that it may have wandered for some time over the plain in the vicinity of Nampa.

From the erosion of the Boisé River since the outflow of lava it would seem that the time which has elapsed since the volcanic outbursts is closely comparable with that which has passed since the outflow of the lava forming the Table Mountain in Calaveras and Tuolumne Counties, California, under which the famous Calaveras skull was found some years ago. Furthermore, the occurrence of late Pliocene fossils underneath the lava in western Idaho shows that the lava at Nampa is certainly post-Tertiary, so that this discovery of human relics may properly be synchronized with those under Table Mountain in California.

In a visit to Sonora, California, and to Bald Mountain, where the Calaveras skull was discovered, I was so fortunate also myself as to run upon evidence of a previously unreported instance of the discovery of a stone mortar under Table Mountain. The mortar was found in October, 1887, by Mr. C. McTarnahan, the assistant surveyor of Tuolumne County. It was lying in the gravel reached by the Empire Tunnel, and about a mile west of the Valentine shaft where Dr. Snell found a similar relic. This tunnel had been excavated seven hundred and fifty-eight feet before reaching the gravel, and the mortar was found one hundred and seventy-five feet in a horizontal line from the edge of the Table Mountain basalt, and about one hundred feet below the surface. The object was taken out and laid beside the mouth of the tunnel, and was given to Mrs. M. J. Darwin, of Santa Rosa, California, who has since given it to me. The mortar is made from a small bowlder of some eruptive rock, and is six and a half inches through; the hollow being about three and a half inches in diameter, and about three inches deep.

At the annual meeting of the Geological Society of America, in January, 1891, a similar mortar was reported by Mr. George F. Becker, of the United States Geological Survey, as found under Table Mountain, about five miles south of the Empire mine, near Rawhide Gulch. Mr. J. H. Neale, a well-known mining superintendent, made his affidavit that he took this with some other objects of human manufacture from undisturbed gravel underneath

the mountain in 1879. At the same meeting of the Geological Society Mr. Becker presented a pestle with a communication from Mr. Clarence King, stating that he found it, about twenty years ago, and took it with his own hands from undisturbed gravel under Table Mountain in the vicinity of Tuttletown, not far from Rawhide Gulch, and still nearer to the Empire mine.

Thus the evidence establishing the occurrence of human relics under Table Mountain would seem to be sufficient, and I should not now repeat the doubts expressed at former times concerning their genuineness. What the final conclusions will be as to the date of this lava-flow, it is now too early to surmise.

SANITARY IMPROVEMENT IN NEW YORK DURING THE LAST QUARTER OF A CENTURY.

By General EMMONS CLARK.

DURING the quarter of a century (1836–1860) preceding the war for the Union, a great change occurred in the character and social condition of the population of the large cities upon the Atlantic seaboard, and especially in the city of New York. The famine in Ireland, and the extreme poverty of the people of that unfortunate country; the unsuccessful revolutions in various parts of the Continent; and the popular belief that Fortune beckoned the poor and oppressed of foreign lands to comfortable homes and to personal, political, and religious freedom beyond the Atlantic, were chief among the causes of the immense emigration at that period to the United States. Immigrants of some pecuniary means and from agricultural districts generally located upon the fertile plains of the Western States, and contributed by their industry and frugality to the rapid growth of new commonwealths. But a very large number, from choice or necessity, and especially the indigent, found homes in the large cities on the sea-coast, and New York received and retained more than its share of the immigrants who were least desirable as a permanent addition to its population. Previous to this tidal wave of immigration, the city was peopled mainly by the descendants of its staid Dutch founders, their thrifty English successors, and the active and enterprising sons of New England. Their dwellings were generally small and inexpensive, and were owned or occupied by single families of moderate income, and the habitations of the more wealthy were quite unpretentious. With the advent of Irish and German immigrants, houses constructed for the comfortable accommodation of single families were transformed to shelter many; their cleanliness and healthfulness disappeared with the numerical increase

and change in the character of the occupants; and new, large, and badly lighted and ventilated buildings were erected as domiciles for immigrants from foreign lands and the native poor. It was at this period and under these circumstances that the tenement-house system of New York was inaugurated, since famous for its extent, and for a long time infamous for its character and influence.

Native-born citizens viewed with considerable apprehension and dissatisfaction this great influx of foreigners, with their diverse languages, customs, and religions; to avoid unpleasant associations they reluctantly surrendered their dwellings and found new homes in the more northerly part of the island, or beyond the East River, in Brooklyn; and this migration continued until large sections of the city were almost entirely occupied by tenement-houses. In all such districts the sanitary condition, which had been fairly good, rapidly deteriorated; the municipal government made no effort to enforce regulations necessary to insure cleanliness and to promote the health and comfort of the poor and helpless; and thus between the years 1830 and 1860 a considerable part of the city year by year drifted into a condition deplorable to the philanthropist and disgraceful to the corporation. The wiser statesmen of that period urged that universal education would be more effective than proscription in removing the acknowledged evils from this immense immigration, and that proper laws and regulations to promote thrift, morality, cleanliness, and health were the true panacea. Free schools for all the people, after a long struggle, were authorized and required by statute. Although the necessity of sanitary reform and improvement was evident, it was not until 1864 that an organized and intelligent movement was made to remove the evils which had gradually accumulated and which seriously threatened the health and permanent prosperity of the metropolis. The great draft riot of 1863, when the city was for several days controlled by the ignorant and dangerous classes, a large amount of property destroyed, many lives lost, business suspended, and the streets unsafe for traffic or passage, was largely instrumental in awakening the New York public to the absolute necessity of reform and improvement in the social condition of a considerable portion of its population.

On the 29th day of February, 1864, at a meeting of the Citizens' Association, at that time an organization of great activity and influence, and composed of the most prominent intelligent and public-spirited citizens of New York, a committee of inquiry was appointed to obtain full and reliable information relative to the sanitary condition of all parts of the city. Upon the report of this committee a Council of Hygiene and Public Health was organized, and under its direction a thorough sanitary survey of the

city was made during the year. The city was divided into twenty-nine sanitary districts, and to each district was assigned a competent physician as sanitary inspector, to make a house-to-house visitation, and to report upon every possible source of preventable disease and every nuisance dangerous to life or detrimental to health. The tenement-houses of the city were a special subject of inspection, the inquiry extending to their cleanliness, ventilation, drainage, and water-supply, the disposal of refuse, location and care of water-closets, number of families and amount of air space, cellar population, and the sickness and mortality. The work was faithfully and intelligently accomplished, and in 1865 the reports of the Council of Hygiene and Public Health and of the sanitary inspectors of districts were published in a large volume. These reports were so startling in their disclosures, and the advent of Asiatic cholera was at that time so imminent, that public attention was directed to the subject, and it was not difficult to secure the enactment by the New York Legislature of 1866 of "an act to create a Metropolitan Sanitary District and Board of Health therein, for the preservation of health and life, and to prevent the spread of disease." This act clearly defined the duties of the Board of Health, and conferred upon it discretionary powers, judicial and legislative, never before intrusted to any executive body in this country. Under this law the Board of Health was organized in New York March 5, 1866, and on the 20th day of April it enacted the necessary sanitary rules and regulations for the government of the city, since known as the Sanitary Code.

To demonstrate the sanitary improvement in New York during the quarter of a century that has elapsed since the organization of the Board of Health in 1866, it is necessary to briefly describe the sanitary condition of the city as it appeared to the Council of Hygiene and its sanitary inspectors in 1864. They reported that the death-rate was largely excessive by reason of the great mortality from contagious and preventable diseases; that the tenement-houses of the city, especially those occupied by many families, were overcrowded, unclean, badly lighted and ventilated, imperfectly drained, supplied with large open privies, which were extremely filthy and offensive, causing discomfort and disease among the tenants, and that the manifold evils of the tenement-house system were intensified in many cases by rear houses in close proximity to those fronting on the street; that many dark, damp, and unwholesome cellars were used as human habitations and crowded with tenants and lodgers; that most of the public streets were paved with cobble-stone, out of repair and very imperfectly cleaned, and were a place of deposit for ashes and garbage; that a large part of the business of slaughtering animals was conducted in the tenement-house districts in dilapidated build-

ings and sheds, which were filthy and in some cases not sewered, the appliances used being inadequate and primitive, and the methods, especially from their publicity, indecent and demoralizing; that cattle were driven through the public streets in populous quarters with great danger to life; that the plumbing and drainage of dwellings, private as well as tenement houses, were extremely defective, allowing sewer-gas to freely escape into the apartments; that offensive odors from gas, fat-melting, and other manufacturing establishments were not uncommon; that stables were generally without proper drainage and very offensive; and that stable manure was allowed to accumulate, was removed irregularly and in an offensive manner, and was stored for sale in the vicinity of dwellings; and that the removal and disposal of offal, dead animals, and night-soil were conducted in a primitive manner disgraceful to a civilized city. It was also reported that there was no proper supervision and care by public authority of contagious diseases or to prevent their spread; that there was no public inspection of the food-supply of the city, and especially of milk, meat, and fish; that there were no regulations or inspections for the purpose of insuring to new buildings proper light, ventilation, and drainage, or to secure the correction of defects and the proper cleanliness of buildings already occupied as human habitations; in short, that the public health received no intelligent consideration from the municipal government, and that the demoralization incident to filthy streets and dwellings and to other unsanitary conditions threatened the material prosperity and the moral and social welfare of the city. Such was the situation in general, as graphically described by the Council of Hygiene, when the Metropolitan Board of Health commenced in March, 1866, the great work of sanitary reform and improvement.

Sanitary reform is of slow growth; for every improvement is an attack more or less important upon the prejudices or the property of a considerable number of citizens and tax-payers, and is, therefore, vigorously resisted. The action of the sanitary authorities of New York has been conservative and conciliatory, but firmly and steadily progressive. By persuasion and explanation important sanitary changes and improvements have been inaugurated, and, when approved by the common sense of the more intelligent and public-spirited, have been completed by legal compulsion; sanitary rules and regulations have been constantly enforced by an expert and vigilant corps of educated inspectors; and thus by a faithful and persistent public service, and without excitement or startling innovations, New York has been gradually relieved of the nuisances which afflicted its people and threatened its prosperity a quarter of a century since. For several years the Croton water supply, so important and essential to the health

and welfare of the people, failed to meet the wants and necessities of the rapidly increasing population, but in 1890 the new aqueduct brought relief; and the only important particular in which no sanitary improvement has been visible is in the cleanliness of the streets and in the removal of the ashes and garbage of the city. It is not creditable to the municipal government that so simple a business problem has not long since been satisfactorily solved.

1. THE DEATH-RATE.—The death-rate of a city for a series of years fairly represents its healthfulness and general sanitary condition. During the ten years, 1851–1860, the average death-rate in New York was 33·66 per 1,000 of its population, or, omitting the year 1854, when Asiatic cholera increased the mortality to 44·36, the death-rate for the period was 32·46. For the five years previous to 1866, in which year practical efforts commenced under ample provisions of law for the sanitary improvement of the city, the average death-rate was 31·33. During the quarter of a century ending in 1890 the death-rate steadily decreased, with the variations from year to year due to climatic and other recognized causes, from 31·33 in 1861–1865 to 25·54 in 1886–1890, the rate in 1890 being 24·58 per 1,000 of the population. This decrease in the death-rate in twenty-five years of 5·79 per 1,000 represents a saving of about 3,300 lives in each year, the average population for the whole period being estimated at 1,153,646, and of over 80,000 lives during the quarter of a century. As the number of cases of sickness is estimated to be twenty-eight to each death, it is obvious that a large amount of suffering has been prevented by improved sanitary conditions, and that the pecuniary benefit to the laboring class and to the poor, consequent upon exemption from expenses attending sickness and death and from incapacity for employment incident to disease, is of great value and importance.

Although a steady decrease is shown in the rate of mortality in New York, it is, from a variety of circumstances, considerably higher than in some of the large cities of this and other countries, and the difference is likely to continue for a considerable period. In no other city is the population so dense and crowded; suburban homes for laboring people so difficult and expensive to reach; small dwellings for people of moderate means so unattainable; and large tenement-houses sheltering many families so necessary and indispensable. No other city receives into its charitable institutions so many weak, sickly, and indigent persons from foreign countries. Its extensive public institutions of charity and correction, all situated within the city limits, are largely recruited from adjacent villages and cities, and its numerous private hospitals receive persons from all parts of the country for surgical and medical treatment. These and other circumstances contribute materially to the mortality of New York, and, while they continue to

exist, its death-rate can not be expected to compare favorably with that of cities more exclusive in respect to the inmates of their public institutions, with comparatively no immigration from other countries, and with the superior sanitary conditions incident to a scattered population and to small and healthy abodes for single families.

2. TENEMENT-HOUSES.—Under an act of the Legislature of 1867 "for the regulation of tenement and lodging houses in the cities of New York and Brooklyn," the improvement of this class of houses commenced, and it has been continued under subsequent enactments with the following results. To improve the light and ventilation of tenement-houses, windows to the halls have been introduced in dark rooms, transom windows over the doors, and ventilators in the roofs over hallways. Privy-vaults and cesspools have been banished, and school-sinks and hopper-closets in the yards, or water-closets and kitchen sinks within the dwellings substituted, all connected with the street sewers. Defects in plumbing and drainage have been removed, iron soil-pipes substituted for imperfect earthenware drains where necessary, and new and improved appliances introduced when practicable. By frequent and thorough inspections by sanitary officers, overcrowding is prevented, cleanliness is encouraged among the tenants, and the necessary repairs and whitewashing secured from owners or agents. In addition to the inspections made upon complaints, and in the course of routine sanitary work, a wise and salutary provision of law now requires that all tenement-houses should be inspected twice yearly. The education of the inmates of tenement houses in habits of cleanliness and as to the importance of minor sanitary rules and regulations, a legitimate result of these frequent inspections and of the visits of a large corps of medical inspectors during the summer months, has been invaluable to the public health. But so long as New York remains the objective point of emigration, and until temperance, frugality, and morality are universal, the ignorant, indigent, intemperate, and irreclaimably vicious part of the population must be an extensive field for the philanthropist and the sanitarian.

The improvement in the plans for light and ventilation, plumbing and drainage of tenement-houses recently erected is the great sanitary achievement of the last quarter of a century. For a long period the standard tenement-house erected in New York was an oblong brick box upon the ordinary city lot, twenty-five by one hundred feet, covering nearly the entire space, four or five stories high, imperfectly lighted and only from front and rear, halls and sleeping-rooms narrow, dark, and unventilated, with no bath, washing, or proper privy accommodations, and generally without Croton water within the building. Not infrequently this plan of construc-

tion was modified by placing a front and rear house upon the same lot, with a narrow alley between, thereby accommodating a greater number of families and more effectually depriving them of air and light. An act of the Legislature of 1879 required that the plans and specifications for light and ventilation of all tenement-houses thereafter erected be filed with the Health Department and receive its official approval before work can commence; and in 1881 a similar requirement was applied to plans and specifications for the plumbing and drainage of all new buildings. Owners, builders, and plumbers are required to construct buildings according to the approved plans, and are vigorously prosecuted for any violation. Sanitary engineers are detailed to inspect as often as necessary every building in course of construction, to report violations of plans and specifications, to thoroughly test the plumbing, and to report the satisfactory completion of all work before the occupation of the building is permitted. As the result of this important sanitary work, the New York tenement-house recently built is a model structure and can hardly be improved. A clear, unobstructed space of ten feet is required at the rear of every such house, with open courts in the interior sufficient in size to afford light and ventilation to every room. At least one water-closet with suitable appliances for flushing, well lighted, and ventilated by a separate air-shaft, must be provided for every fifteen persons. The cellars are lighted by windows to the external air, their floors are concreted, and their ceilings plastered or sealed with boards. The old hydrant in the yard, with its cesspool for receiving the slops and liquid waste of many families, has disappeared, and water is supplied to each apartment with suitable kitchen sinks and wash-tubs. The plumbing and drainage conform to the most approved system, and earthenware pipes with leaky joints, and untrapped and unventilated waste-pipes, are unknown in the modern tenement. The old tenement-houses are rapidly yielding to the encroachments of business, and are replaced by factories, stores, and warehouses; and this fact, together with the proper enforcement of the laws and regulations in respect to the erection of new houses and the conversion of private dwellings to the use of many families, practically solves the tenement-house problem.

3. LODGING-HOUSES.—The laws relating to the light, ventilation, plumbing, and drainage of tenement-houses in New York also apply to the numerous lodging-houses which shelter for a night at cheap rates the unemployed laborer, the homeless poor, and in some cases the vagrant and the outlaw. Twenty-five years since no supervision or sanitary control was exercised by the public authorities as to the character or condition of apartments used for lodgers of this class; and cellars, dark, damp, and unventilated, were commonly occupied for this purpose and were distinguished

for their uncleanliness and foul odors, and as the prolific source of pestilential disease. All such cellars have since been vacated, and the use of apartments below the street level for lodgers is now prohibited. Without a permit from the Health Department a lodging-house can not be maintained, and permits are granted only after a careful survey of the premises, and upon official reports that the buildings and fixtures conform to the laws and to the Sanitary Code. The number of lodgers allowed in each room is proportioned to the air space, four hundred cubic feet being the minimum for each person; and the overcrowding of lodging-houses is prevented, and the condition of the permits and proper sanitary rules are enforced by frequent official inspections, often made after midnight. In no particular is recent sanitary work more commendable than in the improved condition of the premises which for a pittance harbor with decency from night to night those unfortunate persons who, from want of employment or some other more deplorable cause, lead a precarious and nomadic existence, but have not yet become objects of public charity.

4. SLAUGHTER-HOUSES.—In 1865 there were one hundred and seventy-three slaughter-houses in New York, and many of them were located in the most populous parts of the city. After a long controversy they were removed from below Fortieth Street, and at a later period to limited districts on the North and East Rivers, and the business is now conducted without public or indecent exposure, in suitable buildings or abattoirs constructed especially for the purpose, with tight floors and proper sewer connections, and with the most improved appliances for utilizing all parts of the animals slaughtered, or disposing of them without offense. Cattle are not driven in the public streets, but reach the slaughter-houses directly from boats, and the adjacent cattle-yards are properly paved and drained. The daily and weekly inspection of these establishments by sanitary officers have secured habitual cleanliness and the observance of the necessary rules and regulations. By these changes and improvements an important industry, which for several years was threatened with banishment, has been retained within the city limits, with benefit to the food-supply and without detriment to the public health. The number of slaughter-houses or abattoirs in the city is now about thirty, and many of them are model establishments in construction, appliances, and management.

5. STABLES AND STABLE REFUSE.—The connection of stables with the street sewers, formerly the exception, is now the rule, and cleanliness and the regular and frequent removal of manure are required. Manure-vaults are only permitted as temporary receptacles; stable refuse is not allowed to be loaded in carts upon the sidewalk or from openings in vaults beneath; the carts are re-

quired to be tight and properly covered, so that no part of their contents will escape into the street during transportation to boats or cars; and the storage of this material in any part of the city is no longer tolerated. While so large a number of horses (estimated at sixty thousand) are in daily use for business and pleasure, the necessary stables and refuse must continue to be a subject of constant sanitary care and attention.

6. OFFENSIVE TRADES.—The business pursuits commonly called "offensive trades" are those which, if conducted carelessly and without the proper machinery and the necessary chemical appliances, become a nuisance detrimental to health. Twenty-five years since there were no proper public or official supervision and control of these pursuits, and they were only restrained from vitiating the atmosphere with smoke, dust, and foul odors by an appeal to the courts and by tedious and expensive litigation. Prompt attention to all complaints, frequent inspections, orders to discontinue business unless conducted without offense, and a vigorous enforcement of the health laws by the sanitary authorities, have accomplished the desired object. Mechanical and chemical devices have been successfully introduced whenever necessary, and it has been completely demonstrated that there is no business pursuit of importance which can not be conducted inoffensively in a large city, if the buildings used are properly constructed, the machinery and methods are thoroughly scientific and practical, and due care and supervision are constantly exercised. The manufacture of illuminating gas, prolific of odors if conducted without the necessary care and expense, has been a subject of frequent complaint, and although efforts for the public relief have often encountered a vigorous resistance, fortified by corporate wealth and the necessity and universal use of the product, the business has been deprived of its most objectionable features, and is comparatively free from offense. The utilization of the various parts of slaughtered animals not used for human food and the methods employed are among the most remarkable of modern sanitary improvements. The fat, which was formerly melted in open kettles, is now rendered in air-tight tanks; the blood which defiled the public sewers, and the offal, from time immemorial a disgusting nuisance, are converted into fertilizers; and the bones and other refuse animal material, by the aid of applied chemistry, have become useful and valuable as commercial articles. It is unnecessary to enumerate the great variety of business pursuits which formerly afflicted the community with smoke, dust, and foul or offensive odors, and which are now conducted without offense or complaint. Only one trade has been hopelessly ruined by sanitary reform during the last quarter of a century; the ancient guild of hereditary night scavengers, the terror of belated, sleep-

less, or dreaming citizens in midsummer nights, ceased to exist, when privy-vaults were generally banished from New York.

7. CARE OF CONTAGIOUS DISEASES.—The prevalence of contagious diseases, and the absence of official care and control a quarter of a century since, is illustrated by the following extract from the report of the Council of Hygiene, 1865 (page 137), upon the sanitary survey made in the previous year:

"With typhus fever and small-pox in nearly ten thousand domiciles of the poor and the ignorant, where every circumstance favored the localization of infection and the propagation of disease, and where gross nuisances and criminal negligence of cleanliness, ventilation, and medical police demanded the presence of intelligent authority, it is justly concluded that the work of sanitary improvement should, if possible, be enforced by legal authority. The records of many a fever-nest during this survey have shown that the legislative and judicial power of an intelligent Board of Health is indispensable. In some instances the incursions of fever into crowded tenements ravaged every family, and not infrequently broke up large families, making fatal victims of the parents and pauperizing their surviving dependants; often the fever has swept through the front and rear domiciles of populous tenement-houses, and thence has been widely diffused by the constantly changing tenants."

The result of official sanitary care and of improved methods is demonstrated by the vital statistics of that period and of the present time. The number of deaths from small-pox was 78 in 1863, 394 in 1864, and 674 in 1865; and from typhus fever 420 in 1863, 764 in 1864, and 501 in 1865. With a population more than doubled, the number of deaths from small-pox were 81 in 1888, one in 1889, and two in 1890, and from typhus fever four in 1888, none in 1889, and none in 1890. The average number of deaths from typhus fever for the ten years ending with 1865 was 291, and for the ten years ending with 1890 was 30, and the average number from small-pox for the same periods were 372 and 92 respectively. These remarkable results must be attributed to the improved sanitary condition of the city generally; to the prompt reports of all cases of contagious disease by attending physicians; to the immediate removal of the sick to hospitals by the health officers, when advisable; to the sanitary inspection of the premises where sickness has occurred, and the thorough disinfection of sick-rooms and of infected bedding and clothing; and to the new and commodious hospitals for contagious diseases erected and controlled by the sanitary authorities, in which the sick are completely isolated and receive the best care and medical attendance. In cases of small-pox, to prevent the spread of the disease, the persons who have been exposed to the contagion or reside in the immediate vicinity are

vaccinated or revaccinated as may be necessary, and are held for the necessary time under official observation. Prior to 1866 free vaccination was obtainable only upon application to public dispensaries; now a corps of expert medical inspectors, by constant house-to-house visitation, offer vaccination to all and urge its acceptance. With the great decrease in typhus fever and small-pox official attention has been specially directed to scarlet fever, diphtheria, and minor contagious diseases; a hospital has been erected for the reception of cases that can not be isolated and properly treated elsewhere; and the same rules and regulations have been applied in respect to reports of cases by physicians, inspection of premises, isolation or removal to hospital, and disinfection of rooms, bedding, and clothing, with results so satisfactory and promising that there is reason to hope for a continued decrease in the sickness and mortality from these dangerous diseases.

8. THE FOOD-SUPPLY.—The frequent inspections, by a corps of experts composed of physicians and chemists, have so improved the supply of milk brought to the city and offered for sale, that this important article is now rarely found diluted by water or otherwise impure. The markets for meat, fish, fruit, and vegetables are also regularly inspected, and the large amount of these articles seized by sanitary officers from time to time and removed to the offal docks as unfit for human food have improved the supply, checked the sale of whatever is unwholesome, and secured more care and caution on the part of dealers and consumers. Chemical analyses of various articles used as food and in its preparation have also resulted in the detection of frauds and the correction of abuses which formerly were not the subject of official interference or action.

9. PLUMBING AND DRAINAGE.—The plumbing and drainage of tenement-houses have already been noticed, but the improvement of private dwellings in these particulars is not less important. Sanitary engineering during the past twenty-five years has become an important branch of science; in practical plumbing there have been remarkable improvements in material, fixtures, and workmanship; householders have been educated in the importance of excluding sewer-gas, odors, and dampness from their dwellings; and competent official supervision of new plumbing, and correction of defective work in houses erected at periods more or less distant, have removed many of the dangers which formerly threatened life and health in the abodes of the rich and the poor.

Several departments of the municipal government in the performance of their duties as prescribed by law have greatly contributed to the sanitary improvement of the metropolis during the last quarter of a century. The cobble-stone pavements have generally been replaced with block stone, and recently asphalt has

been extensively introduced, thereby making clean and dry streets possible; the sewer system has been extended upon scientific principles, and antiquated and defective sewers removed; new piers have been constructed upon an established line and uniform plan, though the number has hardly increased with the commercial demand; loss of life and accidents from fire have been materially decreased by an admirably organized and disciplined department; and ample provision has been made for extensive public parks; and one of them, which is unrivaled for its beauty and perfection, notably contributes to the health and pleasure of the people.

It must not be inferred or understood, from this brief and general sketch of sanitary reform in New York during the last quarter of a century, that perfection has been reached and the work entirely accomplished. Important steps have been taken in the right direction, and wonderful progress has been made, but the field is wide and open for future activity and effort. The results can hardly be so extraordinary and revolutionary in a similar period, but the work will continue eminently useful in decreasing human suffering and the rate of mortality. To make the metropolis of the country a healthful and desirable place of residence for the rich and the poor, and attractive as a resort and a temporary abode for people of this and other lands, is an object not unworthy the energy, ability, and ambition of any American citizen.

DEPORTMENT OF SAVAGE NEGROES.

By PAUL REICHARD.

EVEN the most thoroughgoing accounts of the customs of savages rarely give full descriptions of their attitudes and bearing. Yet these are the points that strike the stranger most forcibly, and are most distinctly remembered by him. A comparison of them with the behavior of more civilized races and of the lower animals might also afford an interesting anthropological study. In my observations among the Bantu negroes, extending from Bagamoyo into the Congo territory, I have found, except for the diversities in the forms of salutation, a great uniformity in the attitudes of the people. My present account will be confined to tribes which have remained free from foreign influence.

The most salient features of the negroes' movements are a general liveliness and a hasty, jerky execution. Their speech is loud and is continually emphasized by gestures, which are a real constituent of the speech, and are made all the same when the conversation is carried on in the dark; and they are so expressive

that it is possible to understand much of what is said without hearing a word of it.

If we suppose ourselves to visit the chief of a negro village, we shall find him sitting in the veranda of his hut with his nobles, and the braves who have come to pay their respects, around him. If it be still early in the morning, there may be here and there a man reclining on his side by the embers of last night's fire, with his head resting in his hands and his knees drawn high up. Most of the negroes sleep in this position, and their bed-places are accordingly so short that stretching at full length in them is attended by inconveniences. When awakened at last by the ascending sun, the sleeper gets himself into a squatting position, stretches his arms forward over his high-drawn-up knees, so as to balance himself, and slowly rises without his hands touching the ground. The accustomed attitude of the chief is to be sitting on a low stool with his arms resting upon his knees, smoking a pipe, while his officers are squatting around him. New-comers to the audience, making the usual salutations, advance carefully as if treading upon glass, and if nobles, and privileged to sit in the presence of the chief, bearing their stools, which they deliberately seat themselves upon. The caller then draws his knees closely up to his breast, lays one arm upon his leg, grasps one hand with the other, and stoops over till his chin nearly touches his knees; or he stretches his legs out, crosses his feet, and rests his hands upon his knees; but the negro men never cross their legs as we do, or spread them apart when they sit down. Nor do they sit in the Oriental fashion. They are fond of getting the forearm into a position where it will have some liberty, and playing with little sticks or straws. A curious position in sitting is with the heels supported against a stick and the toes resting upon the ground, while the legs are doubled upon themselves and the arms are left free from the elbow down. Some dispense with the stick and squat upon their heels, while only their toes touch the ground. They then have to use a stick, bow, or lance as a support.

The standing negro keeps his legs close together, with the knees inclining slightly inward, so that the feet touch and the great toes can play with one another. With his back somewhat bent, notwithstanding his broad shoulders and muscular figure, he gives the impression of a weakling. In one hand he holds his bow and arrows, while with the other he carries his spear over his shoulder. In time he will change his position, and, supporting himself by his right shoulder, will plant his left leg straight upon the ground, and set the sole of his right foot against his left knee, leaving the right knee to project forward at an acute angle. This is one of the most peculiar and characteristic attitudes of the negroes. If they rest their hands against their sides,

it is always with the palms forward, never with doubled fists or the fingers turned backward. A common position is to lean toward a post, with the hand holding to it away up, but only the forearm coming in contact with the post. The negro sedulously avoids touching a tree or the walls of his house with his naked body, for fear of soiling his anointed skin.

At the special audience we witnessed, a messenger was received, with a report of a military expedition. He was called Fingamaguha, or bone-gatherer, from his habit of fixing in his curly locks a bone from every fowl he killed. In saluting the chief he put on a sober expression, halted, drew his limbs up, bent his knee so as not quite to touch the ground, and clapped his hands three times. Before approaching the powerful Wama chiefs, the messenger must besmear his body and face with mud and roll in the dust. Among the East Coast negroes the usual salutation consists, besides the customary phrases, in extending the hand. The Wanjamuesi lightly press the palms together and then draw them quickly over one another till only the middle fingers touch, when those fingers are snapped upon the thumbs. The Wama, west of the Tanganyika, in saluting lay their weapons on the ground, bow to the earth, and rub their arms, breasts, and foreheads with dust.

Women show their respect for the stronger sex by stepping sidewise out of the road and turning their backs to the man; or else they pass, assuming a position of trying to creep under something. In saluting one another the Wanjamuesi women make a half turn and a straight courtesy.

The chief beckoned to the messenger by stretching his arm out, with the back of the hand up, and making a motion of drawing with his finger two or three times under the inner part of his hand, as if he would draw the man in. Fingamaguha enforced his affirmative answer to the first question asked him by moving his chin backward and forward and lifting his eyebrows. Answering no to another question, he raised his shoulders and dropped them instantly. In expressing doubt, the negro draws his shoulders slowly down and inclines his head to one side; but he is not acquainted with any such sign as that of shaking the head in negation.

Previous to calling upon the messenger to begin his report, the chief offered him a cup of *pombe* or beer. The brave received it, supporting his extended right hand with his left. This using of both hands in acceping a gift—even if it be as insignificant a thing as a needle—is a matter of politeness. It emphasizes the importance of the present.

After prostrating himself, Fingamaguha began his story, holding one hand in the other, and accompanying each state-

ment with its appropriate illustrative sign. To mark the time of making the attack, he turned to the east and pointed to the horizon with his hand; it was at sunrise. Having no division of the hours, the negroes thus mark the time of day by moving the hand till it points toward the spot in the sky where the sun would be at that hour. That the troop were fully armed and had their powder-horns well supplied was shown by the gesture significant of any fullness occasioned by a living being by pounding the right hand into the hollowed palm of the left so as to produce a dull sound. This sign is applicable to the filling of a dish, to an abundant harvest, or to a considerable collection of men or animals, but never to the overflow of a lake or water-course in the rainy season. The soldiers' patient endurance of their toilsome march was described with a series of nasal sounds and a backward and forward movement across the breast of the hands, with the palms turned toward one another; the empty condition of a deserted village which the company came upon, by waving his extended right hand in a curve from right to left up to his mouth and blowing into it; and, to emphasize the emptiness, drawing the hands rapidly over one another, and lightly clapping with them. The hunger suffered in consequence was depicted by slapping his hand several times on his shrunken belly. A motion of drawing the hands alternately one over the other, pulling at them as one would to pull off a glove, illustrated the enjoyment of a surfeit of provisions at another village. The same gesture may signify that all the inhabitants of a place have died or been killed. The storming of the enemy's village was described in a lively manner, with representations of the stealthy approach in the early dawn, and the sudden outbreak of the musketry, for which the symbol was "*To! to!*" as we would say "Boom! boom!" The manner of death of those who fell was illustrated by imitating the respective motions of using the weapons by which they were killed—the lance, bow and arrow, and gun.

Fingamaguha's narrative was received with mingled wonder and incredulity; and certain incidents, which had a humorous side, with boisterous laughter. A common attitude in listening was that of spreading the tips of the fingers over the upper lip, while the elbow was supported by the other hand; and the negroes may often be seen sauntering around in a similar attitude. When the story-teller's word was doubted, he fortified it by drawing his hand across his neck, as if to signify that they might cut off his head if it was not true.

The graces exhibited by the negroes in the dance that followed and was much admired by them, were not such as Europeans are pleased with. Their movements were shuffling, slovenly, and awkward, yet quick and vigorous, and were marked by hold-

ing the limbs and body as closely together as possible. All the dances have an obscene element, and, with the exception of the war-dance, suggest nothing higher than an exaltation of physical love. The war-dances, whether executed as entertainments or as a part of serious work, include a series of boastful, challenging movements. In those of the Wanjamuesi, a champion who has killed an enemy in battle executes an attack against a drum that stands in the middle of the circle of dancers. Approaching the instrument with great solemnity, or with leaps, he assumes a position like that of a theatrical hero who is fulfilling an oath of vengeance. With upraised lance he points to all the quarters of the sky, to indicate that he has performed his deeds everywhere. Then he looks wildly around, nodding his head energetically without bending his neck; nods a second time, holding his head straight up and only bending it forward; and again, with his whole upper body. In another war-dance one of the participants takes a lance or a stick and goes around the circle of dancers in a stooping position, stabbing at a feigned enemy who is supposed to be lying on the ground; then, leaping into the air, strikes at him horse-fashion, with one leg, but without touching any one. A common, peculiar movement of sand-shoving is regarded as a very imposing challenge. The performer, stooping a little, strides along with a gliding step, shambling at every few paces with his foot along the ground, so as to draw a line after him, then slowly raises his foot and pushes the sand forward. His impudent bearing gives the performance the offensive aspect it is intended to bear, which is emphasized by his kicking backward with most contemptuous gestures at his enemy, culminating with looking down between his legs at him. When a traveler in Africa, after a few rubs with the natives, finds them drawing lines with their feet in the sand, he may be sure that mischief is brewing against him. These, and a variety of other performances of similar import, are employed in earnest as well as in the dance and the sham battle; and even when death has reaped its harvest there still prevails a peculiar humor, with shout and song, and the adversaries continue to mock one another.

On occasions of grief the negro sits with his chin in his unsupported hand, slowly shaking his head. Weeping and shedding of tears are rarely witnessed. Mourning is exhibited by tearing the hair and a distressful howling.

Anger is manifested with great show of violence. The raging negro distorts his face, bites at his finger but without harming it, while the froth runs out of his mouth. The gesture of slinging away this froth with the middle and fore-finger is also employed in times of grief, or when anything unpleasant has occurred. The angry man beats around with his club, striking vessels, trees,

the ground, and the roof-thatch, wisely taking care not to encounter any man, and is heartily glad when they hold him, take his weapon away, and try to quiet him. There is seldom any real clubbing. Appearing extremely angry, disputants stand opposite one another, calling names in voices of excited tones. If a real fight sets in, the bystanders interfere and separate them.

The negro is capable of great endurance in work when he makes up his mind to it. Field labor, felling of trees, and the women's stamping of meal are performed standing; other kinds of work in a squatting or sitting posture. In making his implements the negro has a correct eye for articles he has once learned to construct. His lances, arrow-heads, stools, and mortars are shaped very exactly. But he has little sense for straight lines. A common position at work is to sit with one knee drawn up to the chin, while the other leg lies bent upon the ground, with the feet touching; or the workman sets the soles of his feet together and spreads his knees out till he can work with both hands between them. Holding under his left arm the object to be fashioned, he draws his little sharp knife toward his body, cutting a thin, single shaving. The knife is held in the right hand, and pressure is applied from the third joint, counting from the tip of the fore-finger. The object is held by the thumb and fore-finger of the left hand, while the middle, fore, and little fingers of the same hand are utilized in pressing upon the back of the knife. The middle is the preferred finger in sewing, weaving, and other minor hand labors, and even in untying knots. The toes are very flexible, and are often engaged in holding goods on which sewing is done. Articles upon the ground, provided they are not too small or inconveniently large, are picked up with their aid. In climbing trees, the foot is planted against the trunk, and the great toe, spread out from the others, helps to secure the grip. An expert climbs with great skill and considerable speed, holding to the trunk with his hands extended as far as possible, and pressing against it with the soles of his feet, without touching it with his arms, legs, or body.

At eating, the negro, having always first washed his hands and rinsed his mouth, sits upon the ground; holds the larger pieces between his teeth while he cuts off a bite with his knife, but does not use both hands to hold food, except in gnawing bones; with the usual dishes, he lays his right arm over his knees and, reaching into the pot, molds the thick mess into lumps about the size of a walnut, which he throws into his mouth with a jerk, without scattering any of the food. To take out vegetables or soup, he presses a hollow into the lump and dips with it. Politeness is shown to the host or the housewife, after eating, by smacking loudly enough to be heard.

While the negro is capable of eating meat in an unpleasant state of decomposition, he is very sensitive against some tastes, and will make evident manifestations of his dislike of them. He is careful about the outer matters in drinking. He will always rinse his mouth first, even when he is intensely thirsty. If the cup is not too small, he takes it in both hands; and he likes to sit down with it. If the vessel is large and open, he draws in the water from the surface with his lips, without bringing them in contact with the dish. Sometimes negroes pour water into their mouths. When drinking at ponds and rivers, the water is carried to the mouth with the hand. For some mystic reason it is considered bad to lie flat down when drinking from rivers. The fear of being snapped up by a crocodile may have something to do with the matter.

Great attention is given in most of the tribes to the care of the body. The teeth are cleansed with a stick which has been chewed into a kind of brush. The hands are washed frequently, not by turning and twisting and rubbing them together one within the other, as with us, but by a straight up-and-down rubbing, such as is given to the other limbs. This manner of washing is so characteristic that an African might be distinguished by it from a European without reference to the color. The sun is their only towel.

The pocket handkerchief is as abhorrent to the negro as his manner of dispensing with it would be to us. The African finds a use unknown to us for his nose by making it a receptacle for carrying his roll of tobacco. Another tobacco-storage place is found behind the ears.

While joyous emotions are expressed in the most lively manner by negroes, signs of love and tenderness can hardly be read in their faces. The kiss is foreign to them, and no negro child has experienced the delight of being petted by its mother. The whole treatment of the child is neutral, and a matter of business. Signs of affection toward women from men are not permitted in public or in the presence of third persons. A negro man can only stare at a woman who pleases him. The women understand coquetry well, and, aside from a greater sensuality and lustfulness in expression, yield nothing in that respect to their white sisters. Marks of mutual regard are observed only among women, in embracings and hand-shakings.

The eye furnishes a very prominent mark of distinction between the white man and the black. The negro's eye usually gives an impression of shyness, which arises from the absence of any sharp line of distinction between the iris and the pupil. The resulting unsteadiness of the look gives the negro an expression of the animal which is not softened by his facial type. His assumed indifference often passes into consequentiality as when

he pretends to know all about what one is showing him. His interest can be aroused only by objects the use of which is plain to him without explanation, or which he fancies have a market value. At them his eyes will shine with greed. Lack of self-confidence makes him suspicious, and his distrust appears in his look. His eyes will shine with his own rage, but no flame of noble indignation can be kindled in them on account of an evil deed or of a wrong of which he is the author.—*Translated for The Popular Science Monthly from Das Ausland.*

POLLEN: ITS DEVELOPMENT AND USE.

By JOSEPH F. JAMES, M. Sc.

WHEN a plant in growing has reached a certain stage in its development, the character of the buds which have before produced branches changes, and flower buds appear. In correspondence with the change of character in the buds, the stem and leaves change also. The former becomes smaller and forms the peduncle of the flower, while the latter, dwindling from true leaves or foliage organs, become bracts, sepals, and petals.

The process of flowering is attended with very important results. While the plant has been growing rapidly, sending out new leaves and branches into the air and new roots into the earth, the total amount of material produced by general growth has not been expended. A certain portion is kept in reserve, and this is drawn upon when the time for flowering and fruiting has come. It is the exhaustion of this reserve of food which causes annuals to perish after perfecting their seed. In biennials a store of matter is laid up one year in the leaves or roots, to be drawn upon by the plant when the flowering time comes round the next year.

Lamarck, about seventy years ago, was the first to detect that a certain amount of heat was evolved on the expansion of the flowers of the European *Arum*. Their *anthesis* is equivalent to a burning up of some of the material of the plant. The heat so produced is sometimes quite considerable, and it can be measured by means of a thermo-electrical pile. A most notable example of the consumption of stored material is to be observed in the century plant. This grows for many years, laying up nourishment in its large, succulent leaves. After from fifteen to seventy years' growth the time for flowering comes; the reservoir of nourishment is drawn upon, the flower stalk is shot up with tremendous rapidity, and in a few weeks the thousand blossoms have opened, faded, and seeded. Then the whole plant dies. It has exhausted its store of nourishment, and consumed itself in the production of

seed. Dr. Gray has likened the plant to the fabled phœnix, which, consuming itself in giving birth to its offspring, literally rises from its ashes.

All the parts of a complete and perfect flower are, morphologically speaking, modified leaves. It can often be observed that true leaves pass insensibly into bracts. These in turn pass into sepals, and these again into petals. Sepals, being as a rule green, can be more easily seen to be modified leaves than petals. The last are usually colored, and the fact is not so noticeable. Yet, in the flowers of the cacti, the line between the outer bracts and the sepals, and between these and the petals, can not be drawn, for they pass imperceptibly into each other. In the *Nymphæa* (water-lily) there are numerous rows of petals, and a gradual change can be traced from the outer row of petals into stamens. First at the tip of a petal are developed two small lobes, one on each side. These lobes enlarge as the center of the flower is reached, and at last a fully formed anther at the top of a slender filament is the result. All the various stages through which the stamen has passed are visible in the rows of petals.

According to Mr. Grant Allen, the original and primitive flowers were made up of stamens and pistils only as the essential organs of the flower; and the petals and sepals are but stamens modified by insect agency. Now, whether petals are regarded as modified stamens or stamens as modified petals is immaterial. There is nothing to prevent the adoption of both views. The stamens must, in the first place, have been leaves; for it often happens that ordinary leaves are found bearing pollen grains on their edges. So, too, the anther is to be regarded as the modified apex of a rolled-up leaf. As the flowers became, in the course of time, more and more suited to insects, some of the stamens were doubtless changed back into leaves in the shape of petals and sepals, while at the same time the true leaves of the stem may have been changed into bracts of various sorts.

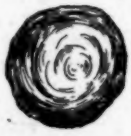
There will be noticed, on the examination of any ordinary stamen, two principal parts. One is the long, slender stalk or filament, and the other is the knob at the end, or the anther. The filament, says Sachs, is to be regarded as the staminal leaf. The anther is made up of two lobes, situated at or near the apex of the filament, one on each side, and separated by a prolongation of the filament known as the connectile. In these two lobes the pollen is developed. Sachs says that "the formation of . . . the pollen grains of phanerogams always takes place by the division of the mother-cell into four parts." This division takes place as follows: In the process of growth of the original mother-cell, the nucleus becomes divided into two parts, each soon forming the center of a new cell. These two again each divide and finally

form four, each one surrounded by a cell-wall, but all still inclosed by the wall of the mother-cell (Fig. 1). On further growth the wall of the mother-cell is ruptured, and the daughter-cells escape as free pollen grains. The wall of the mother-cell is then either absorbed, or remains in the form of threads between the grains, or as viscid matter on the outside of the grains.

FIG. 1.—*a*, Mother-cell, with two nuclei; *b*, mother-cell divided into two cells; *c*, mother-cell divided into four cells.

Thus pollen grains are daughter-cells, which have been developed from a primal mother-cell. Each grain is made up of three parts. There is an outer wall (extine), an inner wall (intine), and the fluid contents (fovilla). The extine is often marked with lines, points, or grooves; the intine is generally smooth and regular, and, even when the extine is studded with points, the intine does not

Showing marks on extine.



With extine removed.

FIG. 2.—HOLLYHOCK.

FIG. 3.—POLLEN OF ŒNOTHERA.

line the inside of these points but extends over their bases (Fig. 2). In cases where there are projections at different points, as in the evening primrose (*Œnothera*, Fig. 3) and others, the intine becomes thickened, and the extine is very much thinner. In the melon (Fig. 4), where the extine has pores provided with lids, the intine at these points is considerably thickened, and in growth pushes the cap off. When, again, a pollen grain appears marked with reticulations and spaces, as in *Pancratium* (Fig. 5), these are regarded as thinner places in the extine rather than special markings.

FIG. 4.—MELON.

FIG. 5.—PANCRATIUM.

It is a well-known fact that the pollen of anemophilous or wind-fertilized plants differs markedly from that of entomophilous or insect-fertilized plants. In the former case it is dry and powdery, probably having this quality from the entire absorption of the

wall of the mother-cell, thus leaving the grains separate in the anther. In entomophilous plants, on the contrary, the pollen is often viscid, or else studded with points, so that it may in some way adhere to the legs, bodies, or probosces of insect visitors.

While, as a rule, the pollen grains are free in the anther cells, there are two families, those of the *Orchids* and the *Milkweeds*, in which the grains are developed in a peculiar manner. In these families, but especially in the former, the grains cohere to one another by means of a viscid matter, and thus form one mass, technically known as a pollinium (Fig. 6). The cohesion is brought about by the walls of the mother-cells remaining, and so binding the grains more or less completely together. The cohesion is but slight, for, on the application of a pollinium to the viscid surface of a stigma, several grains are left on it, and thus one pollen mass will serve to fertilize several flowers. One of the most striking features of these pollinia is that the stem or caudicle undergoes on exposure to the air an act of depression (Fig. 7), so that while it stands erect on its first withdrawal from the anther cell, in a short time a contraction in the substance of the caudicle is observed, and then the pollinium becomes horizontal.

FIG. 6.—POLLINIUM UPRIGHT.

While in ordinary cases pollen is yellow, there are instances in which this feature varies. For example, in one form of flower of loose-strife (*Lythrum salicaria*) it is green. In the willow-herb (*Epilobium angustifolium*) it is blue. In the tulip it is black, and in mullein (*Verbascum*) it is red.

The seeds of flowering plants are produced by the action of the pollen on the stigma. Though both bulb and seed bear in themselves the potentiality of the future plant, the two are very different. This difference can be well stated by saying that the bulb perpetuates the individual, and the seed the species. When the anther is nearly ripe, its inner wall becomes thinner and thinner, either along certain lines or in particular spots. The process continues until by pressure the wall is ruptured at these places and the pollen escapes. When the grains are placed upon the viscid stigma, the moisture absorbed by endosmose causes the contents to swell, and the intine bursts through the thin places in the extine and protrudes in the form of a tube, which penetrates the stigma to the ovary (Fig. 8). While the tube is at first only a projection of the intine, it afterward becomes a growth, for it is many times larger than could be contained in the grain. It is, therefore, nourished by the conducting tissue of

FIG. 7.—POLLINIUM AFTER DEPRESSION.

the stigma. The fovilla, or the mucilaginous fluid filling the grain, proceeds by endosmose into the tube, and thence to the ovule. An effort has been made to disprove the statement that pollen tubes penetrate the style, and so fertilize the ovules; but the great mass of evidence, and the statements of many observers who have seen the tubes in contact with the ovules, indicate that the tubes sent out from the pollen grains *do* penetrate the style, and then are brought into contact with and fertilize the ovules.

It is a strange fact that pollen grains are often entirely inoperative on the stigmas of the flowers that produce them. It has been found by many experiments that, when certain flowers are inclosed in nets, and insects thus excluded from them, if the pollen be applied to the stigma of the flower that produces it, the capsules never set seed; but, if the pollen of another flower be applied, then the stigma is fertilized and seed is produced. In the California poppy (*Eschscholtzia*) there is a remarkable instance of this. Fritz Müller, in Brazil, found it completely sterile with its own pollen. Darwin, in England, found that even with the Brazilian stock of Müller he could get only a few seeds. Thus the sterility appears to depend on other things besides the pollen, the climate, perhaps, having some effect. Sometimes, too, it happens that, if the home pollen grows, and then foreign pollen be applied, this last grows faster and crowds out the first sort.

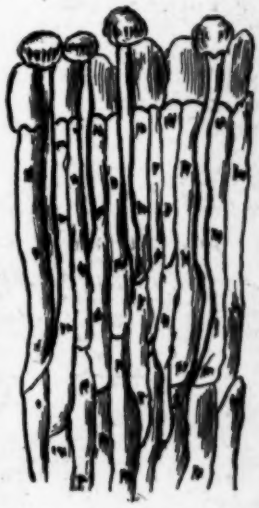


FIG. 8.—POLLEN ON STIGMA OF *Antirrhinum majus*. (After Brongniart.)

The immense number of pollen grains produced by a single flower apparently militates against the saying that Nature allows nothing to be formed but what is needful. It seems, indeed, a vast waste of material to have such a multitude of grains when so very few would answer the same purpose. In a single flower of the peony there are about three and a half million grains; a flower of the dandelion is estimated to produce nearly two hundred and fifty thousand; the number of ovules in a flower of the Chinese wistaria has been counted and the number of pollen grains estimated, and it is found that for each ovule there are seven thousand grains. While few fall below the thousands, many rise far above the peony in point of numbers. These are the wind-fertilized flowers, and here Nature must provide for an immense loss of material. Darwin says that "bucketfuls of pollen have been swept off the decks of vessels near the North Ameri-

can shore. . . . Kerner has seen a lake in the Tyrol so covered with pollen that the water no longer appeared blue. . . . Mr. Blackley found numerous pollen grains, in one instance twelve hundred, adhering to sticky slides, which were sent up to a height of from five hundred to a thousand feet by means of a kite, and then uncovered by means of a special mechanism." The so-called showers of sulphur which have at times visited various cities, notably St. Louis, are nothing but clouds of yellow pollen blown from pine or other forest trees from some distant place. Perhaps, out of millions of grains thus scattered far and wide, only a single one may be of service.

As if to compensate for this expenditure of pollen in some plants, there are others in which the amount is very limited, and where nearly every grain is made to count. These are known as cleistogamous flowers, a term applied to those which always remain in the bud. These flowers are found in plants belonging to about sixty different genera of various orders, and generally in those species which at the same time produce the normal and conspicuous flowers. These large blossoms are often sterile, and the plant must depend on the cleistogamous flowers for its seed. In the wood-sorrel (*Oxalis acetosella*), these flowers have each about four hundred pollen grains; the touch-me-not (*Impatiens*) has only two hundred and fifty, and some violets only one hundred. Even before leaving the anther cells the grains in these cases have protruded their pollen tubes; these seek the pistil and penetrate to the ovules.

FIG. 9.—BARBERRY. *f*, filament; *a*, anther; *s*, stigma; *p*, pollen. (After Lubbock.)

It might perhaps be supposed that, as the seed can be produced so easily, all plants would have cleistogamous flowers. But here

FIG. 10.—COROLLA OF *Kalmia*. (After Gray.)

ANTHER.
p, processes.

FIG. 11.—*Erica tetralix*, WITH PENDENT ANTHERS AND PROCESSES. (After Lubbock.)

comes into play the fact that continual close fertilization is a great detriment and not a benefit, and that it is better in the end that

flowers produce an apparently wasteful amount of pollen and take the chances of a cross, than to be more economical and be perpetually self-fertilized.

A few words now as to the movements of the stamens in connection with the ejection of the pollen. The contrivances for this are various. In the barberry (Fig. 9) the anthers are provided with valves which fly up and throw out the pollen when the base of the filament is touched. In the sheep-laurel (*Kalmia*, Fig. 10) the anthers are lodged in little pits on the corolla lobes, and the filaments are in a state of tension. The anthers open by terminal pores, and when the base of the filament is disturbed the anther is released from the pit and flies forward, this movement throwing the pollen out of the pores at the apex. The anthers of the heather (*Erica tetralix*, Fig. 11) are provided with processes projecting backward and nearly touching the sides of the corolla tube. As they have terminal pores, and are pendent, when the processes are jostled, as they would be by the visits of insects, a shower of pollen falls upon the visitor. Lastly, in the sage (*Salvia*, Fig. 12), the anthers are separated by a long connectile which is hinged at the top of the filament in such a way as to cause one of the anthers to come forward and downward when the other one is disturbed and pushed backward. They are at the same time so placed in the corolla tube that the movement is inevitable, and the distribution of the pollen certain, when an insect visits the flower.

Natural position. When moved by insect.

FIG. 12.—SALVIA. (After Lubbock.)

INSTANCES have been often reported in which fish have been frozen in cakes of ice and recovered their vitality when thawed out. Fish are mentioned in Franklin's journey to the polar seas that froze as fast as they could be taken from the net, so that they were split open with a hatchet, and yet became lively when placed before the fire. The phenomenon is referred to by Izaak Walton. Mosquitoes are said in the Quarterly Review to have been frozen on to the surface of a lake in the evening, and thawed again by the morning sun into animation. Alpine climbers sometimes pick up butterflies lying frozen and brittle on the snow, which revive and fly away when taken to the lower warmer regions. Insects which habitually hibernate, as larvæ or pupæ, do not suffer from being frozen for a lengthened time; but they suffer in open winters from frequent alternations of wet, warmth, and cold.

THE METEORITIC HYPOTHESIS.

By J. ELLARD GORE, F. R. A. S.

MUCH has lately been heard about the "meteoritic theory" as an explanation of the origin and construction of the heavenly bodies. This hypothesis, now generally ascribed to Prof. Lockyer, seems to have been first suggested by the German astronomer Meyer. His theory has met with some support from Helmholtz, Proctor, Thomson, and Tait in Europe, and from Profs. Newton and Wright in America. Prof. Lockyer has recently published a full exposition of his theory in an elaborate and interesting work entitled The Meteoritic Hypothesis: a Statement of the Results of a Spectroscopic Inquiry into the Origin of Cosmical Systems. In this volume the author has worked out his hypothesis in great detail, and, as his theory has recently met with much adverse criticism, a brief review of the principal factsa nd arguments advanced by Lockyer, and also by his opponents, may prove of interest both to those who accept and those who reject his views.

Lockyer commences his work with an account of the falls of meteoric stones recorded in history. The earliest of these dates back so far as 1478 B. C., but, of course, with some uncertainty. Numerous well-attested falls are, however, referred to, and many of these meteorites are preserved in museums, one weighing over three tons being deposited in the British Museum. This fell at Cranbourne, Australia.

The general form of these meteoric stones is fragmentary, indicating that they are the fractured portions of larger masses, burst asunder by the force of the explosion which usually accompanies these interesting phenomena. In the case of the meteorite which fell at Butsura in 1861, pieces picked up at places three or four miles apart could be actually fitted together to form the original mass.

Meteorites are generally covered by a black crust, clearly caused by the intense heat developed by the mass in rushing through the earth's atmosphere with a planetary velocity.

Meteorites are generally composed of well-known terrestrial elements. Among these may be mentioned iron, nickel magnesium, manganese, copper, carbon, sulphur, etc. Some of them, however, contain mineral compounds which are "new to our mineralogy," such as compounds of sulphur and calcium, sulphur with iron and chromium, etc. Some meteorites contain a large quantity of hydrogen gas, which has been absorbed or "occluded"; others contain carbonic-acid gas. Some are composed chiefly of iron, others mostly of stony matter.

Prof. Lockyer made a number of careful experiments on the spectra of fragments of "undoubted meteorites," obtained from the British Museum. These were examined at various temperatures, varying from that of the "Bunsen burner" to that of the electric spark with Leyden jar. He finds that, at the lowest temperature, the most prominent line of magnesium is a fluting near the wave-length 500. I may here explain that by the term "fluting" is meant a series of bright lines, usually three, which are sharp on the side toward the red end of the spectrum, but have a hazy fringe on the blue side. These "fringes," when examined with a powerful spectroscope, are seen to be composed of a number of fine lines very close together. In the case of "iron" meteorites, the lines of manganese are the first to make their appearance, owing to its volatility being greater than that of iron.

Lockyer finds that only the lowest temperature lines of magnesium, sodium, iron, chromium, manganese, strontium, calcium, barium, potassium, bismuth, and nickel are seen in the spectra of the meteorites.

He shows the probable identity of origin of luminous meteors and falling stars with meteorites, and also that comets are probably composed of meteoric stones. Discussing the observations of the aurora, he attempts to prove that the phenomenon is due to meteoric dust in the "higher reaches" of our atmosphere, and that the characteristic line seen in the auroral spectrum is identical with the brightest fluting of manganese. Dr. Huggins's researches, however, show that this coincidence does not exist; and some recent experiments made by Messrs. Liveing and Dewar with an electric discharge passing through dust show that the dust does not act like a gas, and does *not* become luminous like the aurora, but that, on the contrary, the electric current drives it out of its path.

Lockyer next proceeds to discuss the appearances presented by comets, and the character of the spectra they show at different distances from the sun, and concludes that their spectra very much resemble the spectra of meteorites seen under similar conditions of temperature. He considers that the light of comets is chiefly due to collisions between the component meteorites, and that the observed transparency of comets may be explained by supposing the meteorites to be small, and separated by considerable intervals. A portion of the light of comets, he thinks, may be produced by collisions between the cometic swarm and other swarms existing in space; and the recorded sudden increase of light in the Pons-Brooks comet of 1883, and the Sawerthal comet of 1888, seems certainly in favor of this idea.

Lockyer holds the view that both shooting-stars and comets did not originate within the solar system, but are of cosmical ori-

gin. This view of the origin of comets was held by the famous Laplace, but Kant thought they originated in the solar system; and the terrestrial origin of meteorites was advocated by Sir Robert Ball and Tschermak.

Lockyer then proceeds to discuss the probable construction of the nebulæ, and concludes that they are probably swarms of meteorites; the collisions between the component meteorites producing the light emitted by these objects. He attempts to prove that the brightest line seen in the spectra of the nebulæ, "the chief nebular line" as it is called, is coincident with the edge of the magnesium fluting seen in the spectra of meteorites. The nebular line certainly lies very near this fluting, but the spectroscopic power used by Prof. Lockyer was quite insufficient to decide so delicate a question. Recent observations by Dr. Huggins, with a more powerful spectroscope, and by Mr. Keeler at the Lick Observatory, with a higher power still, have, however, shown that the chief nebular line in the spectrum of the great nebula in Orion, and in some others, does *not* coincide with the edge of the magnesium fluting, but falls within the fluting, toward the blue end of the spectrum.

Classifying the stars in accordance with his theory, Lockyer places some of them on the rising branch of a temperature curve, and others, including our own sun, and stars with similar spectra, on the descending or cooling branch of the curve. From an examination of the spectra he considers that the red and orange stars of Secchi's third type, which includes many variable stars, are increasing in temperature, while the still redder stars of the fourth type, of which some are variable also, are cooling bodies, and are "approaching the extinction of their light." The stars showing bright lines in their spectra, he thinks, "are nothing more than swarms of meteorites, a little more condensed than those which we know as nebulæ." He identifies some of the bright lines visible in these stars with the lines of hot carbon, but this conclusion is disputed by Dr. Huggins.

Considering the subject of the binary or revolving double stars, Lockyer considers that they are merely condensed swarms of meteorites, which had probably their origin in a single nebulous mass, or a double nebulosity. He explains the phenomena of long-period variable stars by supposing one swarm to revolve round another in an elliptic orbit, the increase of light at maximum being caused by collisions between the meteorites of the swarms when they clash together at the periastron. This seems a very plausible hypothesis, and quite as probable, I think, as other theories which have been advanced to explain the phenomena presented by these interesting and mysterious objects. Bright lines have been observed by Espin in several of the most remarkable

variable stars when near their maximum brilliancy, and these may very possibly be due to the heat produced by meteoric collisions.

Prof. G. H. Darwin, the eminent Cambridge professor, has proved mathematically one point in favor of Lockyer's hypothesis. He shows that the conception of fluid pressure required by Laplace's nebular hypothesis, and which is applicable to a gas, is also applicable to a swarm of meteorites. The pressure exerted by a gas against the surface of an inclosing vessel is supposed to be the result of collisions between the component molecules of the gas, and Prof. Darwin shows that, if we supposed these molecules magnified up to the size of meteorites, their collisions will still give a *quasi*-fluid pressure, and that the law of gases will be applicable to a swarm of meteorites. One objection may be raised to this view, namely, that the ultimate molecules of a gas are supposed to be perfectly, or at least highly, elastic, while meteoric stones have very little elasticity. Prof. Darwin, however, points out that, when the meteorites come into collision, the heat generated by the shock volatilizes a portion of each, so that the result will be like that of an explosive, and consequently there will be nearly perfect elasticity. He finds, further, that the analogy with the theory of gases will hold good for the meteoric swarms from which the solar system—on Lockyer's hypothesis—is supposed to have been evolved, a swarm extending beyond the orbit of Neptune. He also finds that the swarm when widely diffused will be subject to gaseous viscosity, and will first rotate as a solid body, but when more contracted "the central portion will revolve more rapidly than the outside."

With reference to the origin of comets, Mr. Monck inclines to the opinion that some comets, at least, originated "within the limits of the solar system," and to this class he is disposed to assign "the four comets which have been connected with meteor swarms." He argues that *some* meteors may be of terrestrial origin, and suggests that possibly Lockyer's experiments may have been made with some of these terrestrial meteorites.

There seems to be another weak point in Prof. Lockyer's hypothesis, and that is that it offers no explanation of how the planets and satellites of the solar system were evolved. This has been pointed out by Mr. Monck. He says: "Will any advocate of the meteoric theory give us an explanation of why all the planets and asteroids and the great majority of the satellites revolve in the same direction, why the orbits of the larger bodies of the system deviate so little from the circle, and why they are so nearly in the same plane? Till this is done I think the nebular hypothesis has in this case the advantage." A violent grazing collision between two dense meteoric swarms might, however, conceivably, be sup-

posed to produce a rotation in the swarms, which would give rise to the observed planetary motions.

Another objection raised by Mr. Monck is, that it seems difficult to understand how the requisite number of collisions in a meteoric swarm could be produced and kept up, and "that meteor clouds dense enough to produce the requisite amount of light by their collisions would also be dense enough to intercept a great part of it again on its way to the earth." Mr. Monck's papers on the subject were published in the Journal of the Liverpool Astronomical Society.

Here the matter rests at present. It will be seen that hitherto the weight of evidence seems against the truth of Lockyer's hypothesis, but further researches on the subject will be looked forward to with considerable interest.—*Gentleman's Magazine.*

OUR AGRICULTURAL EXPERIMENT STATIONS.

By Prof. CHARLES LATHROP PARSONS.

WHEN, in 1851, a small local society of German farmers at Möckern, Saxony, realizing that scientific investigation could help solve the many obscure problems of their life, contributed from their own resources and asked their Government for aid to establish an experiment station to study such problems, a new epoch was begun in the history of agriculture. The idea that scientific research could be of use in studying and solving the questions related to the farm was by no means a new one. The educated proprietors of Europe were even then beginning to reap the proceeds of chemistry applied to agriculture. The work of Chaptal, Davy, Sprengel, and De Saussure, in the earlier part of the century, had been continued, supplemented, broadened, and enlarged by the great chemist Liebig, whose Chemistry in its Application to Agriculture and Physiology had opened the eyes of many well-known scientists, and given to intelligent farmers a new and brilliant field of labor.

In 1834 Mr. John Bennet Lawes, since knighted in reward for his labors, began experiments upon fertilization on a small scale. He gradually increased them until 1843, when he associated with himself the now celebrated chemist, Dr. J. H. Gilbert, and from that time he dates the establishment of the Rothamstead Experiment Station. Almost coexistent with the first work of Lawes in England, Boussingault began the study of plant physiology and nutrition on his farm and in his private laboratory in Alsatia. Many schools and universities already had zealous workers in

this field, and numerous agricultural societies had their more or less active chemists.

But the epoch begun at Möckern in 1851 was new. The work which had been already accomplished had been so brilliant, so practical, so helpful, that when the society at Möckern established the first German experiment station, and secured government aid for it, the scientific German mind became fully aroused. It needed but two years of its valuable work to demonstrate its usefulness, and in 1853 the good example set by the Möckern farmers was followed by those of Chemnitz, also in Saxony.

From this time on agricultural experiment stations have multiplied so rapidly in Europe that it has been almost impossible to keep statistical pace with their growth. In 1856 there were five, in 1866 there were thirty, in 1873 there were sixty-three, while to-day there are one hundred and ten in France and Germany alone.

Fortunately for American farmers, a young American of exceptional intellectual abilities, reared in an agricultural community, and full of interest and zeal for his chosen profession of chemistry, went to Germany in 1853 to finish his studies at the University of Leipsic. Although Samuel W. Johnson had chosen scientific pursuits, he had by no means lost his interest in rural life, and, when led by chance or accident within so short a distance of the new station at Möckern, he at once became imbued with its life and spirit. The career of Samuel W. Johnson, now Professor of Agricultural Chemistry in the Sheffield Scientific School, and Director of the Connecticut Agricultural Experiment Station, was begun, and a fame was started which, gradually increasing with his investigations and published works, has reached a height in agricultural science which many will strive to reach in vain. He must always be considered the pioneer of America in science applied to agriculture. Fortunately, also, another young man, whose chief fault was in being born a few years later than his teacher, went to take a post-graduate course under Prof. Johnson, at New Haven. Receiving his doctor's degree in 1869, Wilbur O. Atwater went to Germany and there made a special study of the then largely increased number of experiment stations.

In 1872 the question had been discussed at a convention held in Washington, but on the 17th of December, 1873, the first direct effort to start an agricultural experiment station on this continent was made. Dr. Atwater on that day read a paper before an assembly of Connecticut farmers, in which he strongly advocated the establishment of such a station. His remarks were supplemented by Prof. Johnson; and, although the idea was new to most of those present, their arguments were so clear and convincing that a committee of eight was appointed to try and secure an appropriation from their Legislature for the purpose. The Con-

necticut Legislature, however, was composed mainly of farmers, and, strange as it may seem, the prejudice and sneers against "book farming" has caused by far the larger number of like bills to fail in such bodies whenever they have appeared. So it was here, although numerous petitions had been circulated about the State and very generally signed. The following winter also much hard work was done to arouse public sentiment in favor of the project; but still the next Legislature, although confronted by an increased number of petitions, could not be prevailed upon to pass the appropriation of $8,000 a year which was asked.

At this juncture Mr. Orange Judd, who had been an enthusiastic believer in the good of such an organization, came forward and offered the use of the laboratories of Wesleyan University, on behalf of the trustees of that institution, and $1,000 on his own part, provided the Legislature would appropriate $2,800 a year, for two years, to help pay the necessary expenses. The matter being brought in this light to the Legislature, it immediately passed the necessary bill, and the first American experiment station was established, October 1, 1875, at Middletown, with Dr. W. O. Atwater, who had been an indefatigible worker for the cause, and to whom the chief credit for the station's establishment is undoubtedley due, as its first director.

The work accomplished in those first two years—accomplished under such disadvantages that only a specialist can realize them—was so helpful to the Connecticut farmers that they could but acknowledge its benefits and provide for its continuance. When the two years were ended, the annual appropriation was increased to $5,000; and the Sheffield Scientific School having offered accommodations, the experiment station was reorganized at New Haven, with Prof. Johnson in charge. Three years later the appropriation was again increased to $8,000 yearly, and a special grant of $25,000 was made to permanently establish it on land and in buildings of its own.

The experiment station thus begun has saved thousands of dollars to Connecticut. Even in the first few years of its existence it was so apparent, and could so easily be shown, that the station was yearly saving several times its cost, that it was impossible for it to remain in obscurity, even if such had been its desire. Its fame soon spread beyond the limits of its own State, and numerous deputations were received from others who desired to examine into its workings. In 1876 California followed the example of the Middletown Station. In 1877 the North Carolina Station was organized. The Cornell University Station came next; then New Jersey, New York at Geneva; Ohio, Tennessee, Massachusetts, and others; so that, when the Hatch act of March 2, 1887, passed Congress, seventeen had been organized in fourteen States.

The so-called Hatch act gave a new and great impetus to the work of experiment stations in this country. It could not have been otherwise, for it made provision for an appropriation of $15,000 a year to each State or Territory that would accept the trust, to establish a station in connection with its agricultural college, or to aid such stations already established. All of the States, except Montana, Washington, and Idaho, have taken advantage of the act, as have also New Mexico, Arizona, and Utah. Some have more than one, and some who have only one regular experiment station have organized one or more branch stations located in different sections of the State. If these branch stations be excluded, there are now fifty-three experiment stations in the United States; while, if they be counted, there are sixty-nine.

Congress saw fit to leave the government of the stations which it established to the various States in connection with their agricultural colleges, whose trustees generally have it in charge, and as a whole, or through properly authorized committees, engage specialists to carry on the work. The scientists thus engaged necessarily vary in their specialties with the lines of research which each particular station desires to undertake. The study of agriculture is a complex one, and there is scarcely a branch of science which is not called upon to take its part in the common advancement. A director is generally the first officer chosen. He is supposed to be a man well versed in the past literature of the subject, well known in his special branch of study, and of good executive ability. In the older stations this office is generally held by a chemist of long experience in agricultural experimentation. This is the case in the Massachusetts Station, where the work of Director Charles A. Goessmann has been of incalculable benefit to the agriculture of his State. This is also true of both Connecticut Stations, of the New York Station at Geneva, of the California Station, the Pennsylvania Station, the North Carolina Station, and others. At present, perhaps in the larger number of cases, the director's office is held by an experienced agriculturist, known for his ability to apply the results of previous scientific research to his particular branch. Besides a director, there are usually one or more chemists, an agriculturist, a horticulturist, and a botanist. Entomologists, veterinarians, meteorologists, biologists, microscopists, physicists, mycologists, viticulturists, geologists, etc., follow numerically in the order in which they are mentioned, and receive their appointment according to the several needs of the stations by which they are engaged. In all there are now four hundred and twenty-three persons employed in these stations, whose names are published as on the station staffs.

Although the experiment stations were left entirely independent of each other and any central head by the Hatch act, so that

they have perfect freedom in their actions so long as they adhere to the purpose of the law, still Congress very wisely established a central office, under the Department of Agriculture, to collect and publish summaries of station work and thought in condensed and popular form for the use of the public; to publish special bulletins for experiment-station workers; digests of station reports; monographs, etc., and in general to serve as a medium of information and exchange.

A movement which in fifteen years increased the number of regularly organized experiment stations in our own country from one to fifty; whose influence has extended to Canada, South America, Australia, and Japan, causing the establishment of similar stations in those countries; which this year will expend approximately $1,000,000 in the United States alone, exclusive of the work of the Department of Agriculture; which during the year will send bulletins direct to nearly 400,000 farmers; and whose workings have been kept, in the main, free from politics must have had a worthy object, efficient workers, and given practical and useful results. That such is the case none familiar with the investigations of at least the older stations can deny.

The science of agriculture must always be the mother of its art, and to aid the art through the study of the science agricultural experiment stations were established. They were started to conduct experiments upon plants and animals and the needs of both; to improve the useful ones and eradicate the harmful; to study their nutrition in all its phases and determine the chemical composition of their foods; to learn how to cure their diseases, and promote their health; and besides increasing their productiveness and the quality of their products by proper food and care, to also introduce new and valuable ones from other localities. They were intended to study fertilizers and fertilization; the vitality and germination of seed; the variability of soils and waters; rainfall and general climatic conditions; and other questions influencing rural economy. But this was not all, for their chief aim was to distribute information, and to help educate the occupants of our farms and plantations, giving new aims, zest, and ambition to their too often humdrum life. In short, the United States experiment stations aim to help the American farmer in mind and pocket.

The greatest obstacle which the stations have met has been a demand by the farmers for immediate results, and a prejudice against the laboratory and its work; but this gradually disappears as the farmers become more and more familiar with science. On this account the older stations are undoubtedly doing better work to-day than those of more recent origin, which are still struggling against this sentiment. Experience has taught, not only in Germany but here, that thoroughly scientific investigation invariably

gives the most practical final result. As a rule, the older stations also have the most experienced and best-known agricultural scientists in their employ; but this is not always the case. With the large increase in the number of experiment stations which took place in 1887–'88 came a corresponding demand for the services of these experienced men, and several accepted more lucrative positions than they had previously held.

The demand for experienced men was, however, far in excess of the supply. From seventeen the number of experiment stations suddenly increased to fifty, with nothing like a proportional increase in men who were capable at the outset of filling the places to which they were appointed. At first, many places were undoubtedly filled by popular favorites, appointed to their positions through the influence of farmers' organizations or for wholly local reasons. Some of these have proved worthy of the trust and by hard study and work are building up their departments and themselves.

But the lack of suitable men has not been the only drawback to the work of the younger stations. Two clauses in the act passed by Congress allowing only three thousand dollars of the first and seven hundred and fifty dollars of each succeeding appropriation to be used for buildings, and requiring that from the very first at least four bulletins a year be issued, while ultimately it may prove of advantage to them, has certainly tended at first to bring them no praise. It was supposed that the States would furnish buildings, but unfortunately some of them furnished either inadequate ones or none at all, and in one or two instances even the annual appropriation which the State had previously given to the agricultural college was abolished. The fact that quarterly bulletins were required by law, whether the station had valuable matter on hand or not, coupled with the fact that in many instances men wholly new to the business had to write them, tended at first to distribute more or less matter of questionable value. As the bulletins have general circulation among the class for which they were intended only in the State in which they were issued, many States necessarily sent out some compilations on the same topics which, to all practical purposes, were duplicates of each other. Bulletins, too, had to be written in popular style, in order that they might be understood by men whose education, in too many instances, had been limited to the winter district school. If it be also remembered that these newly formed stations have been organized scarcely three years and have not been in working order for that length of time; that they are going through the same trials as the older stations have had; that they have to break down the prejudices of many farmers, as the older stations have largely done; and that they were popularly expected to show in a few

months results equal to those which even the German experiment stations have conquered only after years of strict application with the aid of the best of the scientists of that scientific nation—it can not be wondered at that these new-born stations have in several instances fallen short of what was expected of them. While in some cases the three-year-old stations may not as yet be able to show results equivalent to the $45,000 received by them in that time, still, as a whole, I think, no intelligent agriculturist familiar with their workings will deny that they have more than returned the appropriations received by them. In fact, I doubt if the increased value of commercial fertilizers, to improve which the stations were first established in this country, has not in itself more than balanced the account.

But while the younger stations are asked for immediate results to meet the popular demand, it must not be supposed that these results are all worthless or hastily compiled. To the contrary, they have profited by the example of the older stations, and many most excellent showings can be made, while many of the bulletins, compiled in some instances from work done at other places, on the scientific principle of stock-feeding, fertilization, and other topics, have been issued as an educating medium, and to familiarize the farmers with unavoidable technical terms and expressions.

While there is scarcely a science that has not been called into play in some one of the experiment stations, still, chemistry has its place in all and is pre-eminent in most. Horticulture, botany, and entomology are of course extremely prominent, while the study of fungi and bacteria is steadily increasing. But to review the present work of the various stations nothing better than the following summary, from an official report of recent date, can be given: "Twenty-seven stations are studying problems relating to meteorology and climatic conditions. Thirty-one are studying the soil, by investigations of its geology, physics, or chemistry; experiments in tillage, drainage, or irrigation; soil tests with fertilizers, or other experimental inquiries. Thirty-five are making analyses of commercial or home-made fertilizers, or are conducting field experiments with fertilizers. Thirty-nine are studying the more important crops with reference to the methods of culture, manuring, and rotations; varieties adapted to different localities and purposes; and chemical composition and nutritive value. Twenty-five stations are investigating the composition of feeding-stuffs, and in some instances making digestion experiments. Seventeen are dealing with questions relating to silos and silage. Twenty-four are conducting feeding experiments for milk, beef, mutton, or pork, or are studying different methods of feeding. Eighteen are investigating subjects related to dairying, including the chemistry of milk, bacteria of milk, creaming, butter-making,

and the construction and management of creameries. At least thirty-three stations are studying methods of chemical analysis. Botanical studies occupy more or less of the attention of thirty-three stations; these include investigations in systematic and physiological botany, mycology with special reference to the diseases of plants, the testing of seeds with reference to their vitality and purity, and classification of weeds, and methods for their eradication. Thirty-five work to a greater or less extent in horticulture, testing varieties of vegetables and fruits, and making studies in varietal improvement and synonymy. Nine have begun operations in forestry. Twenty-five investigate injurious insects, with a view to their prevention or destruction. Fifteen give attention to veterinary science. At least four are experimenting in apiculture and three in aviculture. Sugar-making is experimented with at six stations, but the Louisiana Sugar Experiment Station does far more in this direction than any other." Thus it will be seen that the work is quite varied and comprehensive.

The work is progressive and is progressing rapidly. As the workers gain new knowledge and experience they gain new ambition to excel and aid the advancement of their particular branch of science by opening to it a new field for development. This field is a grand one; few have more or more interesting problems to solve or offer more for their solution.

In the fifteen years during which experiment stations have existed in the United States much advancement has been made in the art of agriculture and much money saved to our farmers. While the stations can not claim sole credit for this progress, they can claim a good share of the praise, and can show many broad and useful results of their work. It is next to impossible to enumerate these results, to show their full application, or even to give examples which will do them justice. Still, a few of general applicability may perhaps be cited with interest.

The chief argument raised in favor of the establishment of the first station in Connecticut was the fact that a few analyses of commercial fertilizers, made in the laboratories of the Sheffield Scientific School, had revealed, beyond a doubt, that immense frauds were being perpetrated in their sale upon the farmers of the State. The fact that crops responded so well to a really good fertilizer, and that it could be easily imitated by a worthless article whose uselessness was only made apparent by chemical analysis or crop failure, made these frauds easy and frequent. When the station was established the improvement of existing fertilizers and exposure of frauds was made its first duty. Before buying a fertilizer, any Connecticut farmer could have it analyzed free of charge, and its ingredients in valuable plant-food were thus previously made known. The station itself sent agents around the State and

procured samples of fertilizers offered for sale, which were also analyzed. Excellent fertilizers were found, others little better than good surface soil; but the price of all was too much in excess of their valuation, or, in other words, the crude materials from which the fertilizers were mixed could have been bought by the farmers for much less than the fertilizers themselves. Finally, the analyses were published, with the poor ones and frauds fearlessly assailed, and the best ones pointed out. The result was inevitable. Honest fertilizer manufacturers co-operated with the station. Other States than Connecticut passed the necessary laws, took up the same work, found the same conditions and eradicated them; so that to-day the average cost of fertilizers exceeds their valuation barely enough to pay for mixing, while frauds have almost totally disappeared. When we consider that hundreds of thousands of tons of commercial fertilizers, averaging at least thirty dollars per ton, are annually applied to our soils, we can scarcely overestimate the value of this one line of work. The Director of the New York Station, Dr. Peter Collier, calculated in 1888 that the effect of twenty years of fertilizer control had been an average saving of 61·43 per cent in the cost of the three constituents of plant-food which are liable to be deficient in soils. The German experiment stations have had very similar experience.

It has long been known that no single plant furnishes the kind and amount of nutriment to give the best results with animals when fed to them, and farmers have used varying combinations of greater or less value for years. The German experiment stations took up, among their earlier investigations, the determination of the basis upon which the efficiency of these combinations rested, and after years of study it was found that it was due in the main to the relation existing between the digestible nitrogenous and non-nitrogenous constituents of the food; that the ratio between these ought to vary according to the purposes for which the animal was fed; and the amount of digestible nitrogenous and non-nitrogenous food which was necessary for the various purposes was determined. The tables thus given to the world by German investigation have been found to not wholly agree with our conditions, but they have been of invaluable service in applying the sound principle which underlies them to American stock-feeding; and it has been an important part of the work of our experiment stations to adapt them to our somewhat different needs. A large amount of success has attended their efforts, and, while the principle of feeding, according to the chemical composition of the food, can not as yet be said to be of anything like general application in the United States, still it is quite widely used, with greater or less success. For the more important purposes for which animals are fed, our ordinary plants, with the exception of some of the leguminosæ,

contain too little nitrogen, and it has been found necessary to supplement them with other more highly nitrogenous foods. This need has served to utilize a number of by-products, as gluten, linseed, and cotton-seed meals, whose value is becoming more and more widely recognized. It has been one of the chief aims of our experiment stations, in extending the scientific principles of feeding, to develop the rational use of these foods, while numbers of farmers with their aid have largely increased their annual products.

One of the great problems which met our agricultural scientists was to arrange some way in which milk could be equitably bought and sold. As the amount of fat in pure milk may vary anywhere from less than three to over eight per cent, it is evident that the value of milk for butter-making must depend upon the amount of butter-fat that it contains. Any chemist can tell us this, but dairies and creameries can not afford to keep their chemists; so it became important to discover some method by which the amount of fat in milk could be quickly and accurately ascertained. For a number of years the attempt proved a failure, for the methods proposed were misleading. As the improved breeds of cattle became more prominent, it became more evident that great unfairness was done in paying a definite price per quart for milk without reference to its quality, and renewed and successful efforts were made by the various experiment stations to obtain some accurate chemical method which could be operated by any dairyman of ordinary intelligence. As a result of the effort, several good methods have been published within the last two years, and one or another of them has come into quite extended use. With the recent greatly increased supply of dairy products came the invariable reduction of prices, and the margin for gain has become so small that only the best cattle can be kept with profit. This fact makes the methods for the determination of the fat contents of milk unusually important, for by their use dairymen can weed out their poorer animals and by careful selection greatly enhance the value of their herds.

The improvements in the methods of extracting sugar from cane in Louisiana; the introduction of the process of "Pasteurization" of wines in California, which does away with the use of antiseptics of any kind; and many other useful results, either wholly or partly due to the experiment stations, might be detailed to advantage. None of them, however, compare with the great improvement among the American farmers themselves. The bulletins of the stations have done and are doing a good work. New facts, new theories, and new interests are daily added to the farmers' lives. A great school is open to them, of whatever age or sex, and they are learning. They are studying science upon their

farms; observing insects, inquiring into the reason of blights and rusts, noticing the effect of different constituents of plant-food upon their crops; helping on their neighbors in the work; and are forming societies, and holding institutes, where they are discussing the scientific and economic problems of their lives with ever-increasing ardor and intelligence. Accustomed from their boyhood to drudgery, from their manhood to labor through all the hours of daylight, they have made a living and, with few exceptions, nothing more. A brighter future, however, lies before them. Our unoccupied arable lands will soon be exhausted, and population is ever on the increase. The farmers will co-operate more and more with our experiment stations, will find more and more beauty in their surroundings and with increased facilities and increased knowledge will take the place which belongs to them in our government and in our nation.

A COMING SOLUTION OF THE CURRENCY QUESTION.

By CHARLES S. ASHLEY.

IT is obvious that the present agitation for the free and unlimited coinage of silver derives its real strength mainly from a general feeling that the cheapening of the standard dollar would make it easier to pay off existing debts.

The great farmer class of the central States have seen their farms shrink in value fifty per cent in ten years—have seen the value of the annual product steadily falling; and in thousands of cases have found a purchase-money mortgage, after being half paid off, still equal to the selling value of the farm. It is natural and inevitable that the causes of this calamity should be largely attributed to the classes who have during the same period been growing steadily richer, and that the great agricultural class should turn to a cheaper currency as a remedy for debts harder to pay.

This is no new phenomenon. English kings, centuries back, when encumbered with debt, solved their difficulties by the easy method of paying their creditors with half the amount of precious metal they had agreed to pay—merely going through the formality of stamping the half by the same name as the whole had formerly borne. Thus the English pound sterling, like the French *livre*, is said originally to have been a pound weight (troy) of pure silver. Now it is equal to less than half that amount. Bluff King Hal the Eighth put two parts alloy to one part of silver into his coins, instead of one part alloy to twelve of silver, as had been and is now the rule. Anything to get the better of the Jew money-lend-

ers was "all right." French, German, and other nations, including the Greeks and Romans, have had a similar and generally far worse history of their coinage.

While it must be admitted that the question of silver coinage, involving as it does the whole history of the production, use, and value of the precious metals, is a great and delicate and difficult problem, I believe there is no controversy about this proposition: that men should pay precisely what they contract to pay—should do just as they agree. The difficulty arises over the question as to what they really agree to do. If they agree to pay one hundred dollars, the question arises, What is a dollar? and the answer must be, in general terms, that it is a monetary unit, composed of a certain amount of gold or silver determined and defined by the United States Government. This leaves open the door for all sorts of honest differences of opinion as to what a dollar really is (since two kinds of dollars are in actual circulation), and also for a very wide field of action for the political power. Manifestly, if contracts were made to deliver a certain amount of gold or silver bullion, or a certain amount of wheat or railroad stock, of specified kind, the ambiguity would not arise.

This is the solution of the currency problem that the financial world, led purely by that enlightened self-interest which is at the bottom of most improvements, is preparing. Several copies of railroad mortgages, made within the last ten years from forms dictated at the great financial centers, lie before me, and in each of them I find the promise to pay "in gold coin of the United States of America of the present standard weight and fineness." For example:

The Toledo, Ann Arbor and North Michigan Railway Company . . . delivers "its certain ten thousand bonds for one thousand dollars each, . . . severally payable to the Farmers' Loan and Trust Company, or bearer, *in gold coin of the United States of America of the present standard weight and fineness* . . . with interest thereon . . . at the rate of five per centum per annum, payable *in like gold coin.*"

No doubt there are hundreds of such mortgages, amounting in the aggregate to at least a billion dollars, and probably much more.*

The highest court of the land has several times declared that such contracts must be performed literally. If a man promises to pay a certain amount of gold, he must do so, whether at the time

* It is not easy to see how many of these companies could escape bankruptcy in the event of the free coinage of silver, if they were compelled to fulfill their contracts to pay in gold coin. While their earnings might rise somewhat from higher charges, it is hardly possible that they could earn thirty-three per cent more in that way—setting aside the likelihood of financial panic and business stagnation.

of payment gold be worth more or less. In Bronson *vs.* Rodes, 7 Wall., 229, Chief-Justice Chase said: "It is the appropriate function of the courts to enforce contracts according to the lawful understanding of the parties. . . . The intent of the parties is clear. . . . A contract to pay a certain number of dollars in gold or silver is therefore in legal import nothing else than an agreement to deliver a certain weight of standard gold, to be ascertained by a count of coins, each of which is certified to contain a definite proportion of that weight. It is not distinguishable, as we think, from a contract to deliver an equal amount of bullion of equal fineness." The same doctrine has been established by the cases of Butler *vs.* Horwitz, 7 Wall., 259, and Tribelock *vs.* Wilson, 12 Wall., 687, the latter case being decided in 1871, Justices Miller and Bradley dissenting. The later case of Gregory *vs.* Morris, 6 Otto, 619, decided in 1877, without dissent among the justices, affirmed the case first cited. And while it is within the bounds of possibility that this doctrine may be upset in some period of great excitement, it is as solidly established as any doctrine can well be, having been affirmed by a large number of the Supreme Courts of the States as well as by the Supreme Court of the United States, which in such matters has supreme authority.*

The currency problem has therefore been taken out of politics in a very large class of cases, and it can readily be done in nearly all. If bankers agree to pay their depositors in coin of a specified kind, say in gold coin of the present standard weight and fineness, regardless of legislation, they can readily make obligations due themselves likewise payable. Bankers, indeed, being subject to demand payments by their depositors, are really under a pledge to pay them in an undepreciated currency, since in the event of a debasement of the coinage the public would at once rush for the more valuable currency; and, as few bankers could stand such runs if made simultaneously on different banks, they are almost unanimously opposed to any change in the currency. The assertion may be ventured that the same causes that have led to the insertion of the above-cited provision in railroad mortgages will lead to similar contracts in other instances, particularly in the case of long-time, low-rate real-estate mortgages to insurance companies. While such changes can not come quickly, the pressure of interest and the universal desire for certainty will lead gradually to the adoption of expedients of the kind mentioned. If this kind of obligations should become common and of recognized validity, it is obvious that the political pressure, now so great, would be entirely neutralized, because few would have anything to gain

* For a collection of authorities, see 2 Daniel on Negotiable Instruments, sec. 1247.

from a debasement or enhancement of the value of the coined dollar.

If the conception of money as a commodity of convenient exchange should altogether supplant that of an artificial standard of value made by Congress out of its own will, the function of the Government would manifestly be reduced to certifying the weight and quality of precious metal in its coins. If it undertook nothing more than this (except the prohibition of coins not issued by itself), there would be nothing to prevent the free coinage of gold and silver, though a slight charge for the expense of coinage would be proper. And with practically free coinage for both metals it is submitted that the varying needs of the country for currency would be more perfectly met than in any other way, because with every "squeeze" in the money market bullion could at once be converted into coin, and *vice versa*. This, indeed, is already provided by section 3518 of the Revised Statutes, which says that the owner of gold or silver may have the same cast into bars with a stamp designating the weight and fineness thereof; but this statute, though no doubt of great use in facilitating the international exchange of bullion, is without the benefit it might have because the bars are not issued in sizes convenient for currency. It is the word "dollar" in existing contracts of indebtedness that prevents this; and if by such action as that above mentioned the word dollar shall be established as the present gold dollar, there would be nothing to prevent a healthy expansion of the currency by the free coinage of silver and the issuance of certificates for the same in any amount desired.

It would be an unspeakable blessing to have the currency question removed from the domain of politics. Questions of so complex a character are precisely those which the people are most ill qualified to decide. It is the interest of all that as few questions as possible having great financial importance should be decided by the political power; for therein lies the source of the corruption of the Government, the oppression of the people, the uncertainty of business, the possibility of panics, a stimulus of class-prejudice and class-greed, and the obstruction of legitimate public business.

*Mr. Warner.**—Corporation after corporation, savings-bank after savings-bank, life-insurance company after life-insurance company, have, since the passage of this last act, felt, not that they wanted anything to happen, but compelled, out of due regard for those whose money they were trustees for, to require that in all reinvestments and loans there shall be put a gold clause. That has actually taken place to such an extent that I believe that,

* Hon. John De Witt Warner, before Congressional Committee, February 16, 1891.

before the time Congress meets in December, in the great money centers this movement will have become general on account of this proposed legislation.

Mr. Bartine.—Do you know whether, after the passage of the former act, contracts were made payable in gold?

Mr. Warner.—Yes, sir; a good many were. . . .

SCIENTIFIC DREAMS OF THE PAST.

By ALBERT DE ROCHAS.

MANY of the inventions which are the glory of our time were foreseen by certain dreamers, in whose imaginations they received a kind of virtual existence. The electric telegraph is foreshadowed by Strada in some twenty verses of his Prolusiones academicæ, which were published in Rome in 1617. To him it was a fancy, a simple wish:

"O! utinam haec ratio scribendi prodeat usu
Cantior et citior properaret epistola!"

The manner in which he understood the instrument was reproduced by all the students of the time, notably by a Jesuit of Lorraine, Père Leurechon, in his Hilaria mathematica, published in 1624. I quote a passage, in which it is mentioned, from the French translation published two years later at Pont à Mousson, under the title of Récréations mathématiques, by an author who signed himself Van Etten:

"There are some who have intimated that absent persons might be able to converse by means of a magnet or some similar stone. For example, Claude being in Paris and John in Rome, if each had a needle rubbed on some stone the property of which was such that as one of the needles moved in Paris the other would move in Rome, it might be that Claude and John would both have a common alphabet, and that if they had agreed to speak from a distance every day at six o'clock in the evening, arranging that the needle should make three turns and a half as a signal that it was Claude and no other that wished to speak to John. Then Claude, wishing to tell him that the king is in Paris (*le roy est à Paris*), will move his needle and stop it at L, then at E, and then at R, O, Y, and so on with the others. At the same time, John's needle, acting in correspondence with Claude's, will move and stop at the same letters so that it will be easy for it to write and make understood what the other means." "The invention is very nice," Père Leurechon remarks, "but I do not believe there is a magnet in the world that has such virtues."

Phonography is thus described in the April number, 1632, of the Courier Vèritable, a little monthly publication in which novel fancies were frequently aired: "Captain Vosterloch has returned from his voyage to the southern lands which he started on two years and a half ago, by order of the States-General. He tells us among other things that in passing through a strait below Magellan's, he landed in a country where Nature has furnished men with a kind of sponges which hold sounds and articulations as our sponges hold liquids. So, when they wish to dispatch a message to a distance, they speak to one of the sponges, and then send it to their friends. They, receiving the sponges, take them up gently and press out the words that have been spoken into them, and learn this by admirable means all that their correspondents desire them to know."

Cyrano de Bergerac, in his Histoire comique des États et Empires de la Lune, whose first edition is dated as early as 1650, is still more precise. He relates that the genius that guided him to our satellite gave him for his entertainment some of the books of the country. These books are inclosed in boxes. "On opening the box I found inside a concern of metal, something like one of our watches, full of curious little springs and minute machinery. It was really a book, but a wonderful book that has no leaves or letters; a book, for the understanding of which the eyes are of no use—only the ears are necessary. When any one wishes to read, he winds up the machine with its great number of nerves of all kinds, and turns the pointer to the chapter he wishes to hear, when there come out, as if from the mouth of a man or of an instrument of music, the distinct and various sounds which serve the Great Lunarians as the expression of language." A few pages before this, Cyrano speaks of transparent globes, that serve for lighting, in which a non-heating lamp has been placed.

We are next told about microbes: "Figure the universe as a great animal; the stars that are worlds as other great animals which serve as worlds to other people like us, our horses, etc., and that we, in our turn, are like worlds in respect to certain animals still incomparably smaller than we, as are certain worms, fleas, and flesh-worms; that these are the earth to others still more imperceptible; and that just as we appear, each individual of us, a great world to these little people, it may be also that our flesh and our blood are only a tissue of little animals which maintain themselves, lend us motion by theirs and let themselves be led blindly by our will which serves them as a coachman, lead us in our turn, and produce altogether the action which we call life. Does not the itch prove what I am saying? Is the worm that causes it anything but one of these little animals which has deprived itself of civil society to constitute itself a tyrant of its country? That

blister and that scab, of which you do not know the cause, have to come, either by the corruption of the enemies which these little giants have slain, or by the plague produced by the remnants of the food with which the disturbers have gorged themselves, and left in heaps of dead bodies on the field; or because the tyrant, after having driven from around himself his companions which were corking with their bodies the pores of ours, has given passage to the humor, which has become corrupt after having been ejected from the sphere of the circulation of our blood. For a further proof of this universal parasitism, you have only to consider how the blood runs to the spot where you are wounded. The doctors tell you that it is guided by Provident Nature, which desires to succor the debilitated parts; which would make us conclude that besides the soul and mind there is in us a third intellectual substance having its functions and organs apart. But for this reason I find it more probable to say that these little animals, feeling themselves attacked, send to their neighbors for aid, and they having come from all around, and the country being incapable of supporting so many people, they die of hunger, or are smothered by the pressure. This mortality takes place when the imposthume is ripe; for the corrupted flesh then becomes insensible in testimony that the animals have been smothered; and that the bleeding which we order to divert the inflammation is because that, having lost much by the opening which these little animals tried to cork up, they refused to assist their allies because they were hardly able to take care of themselves."

Cyrano tried to go up to the moon by tying around his waist bottles full of dew, which, according to the opinion then received, was attracted by the sun. He was not able to rise so high; but, after breaking a considerable number of bottles, he pretended almost to nullify the weight of his body, so that he could travel by long leaps, only grazing the earth, as many people fancy in their sleep that they are doing. "He reached the moon by means of a machine which he does not describe, and found there another terrestrian who had raised himself up by the aid of a Montgolfier and a parachute. He filled two large vessels with smoke, sealed them hermetically, and fastened them under his arms; the smoke, which tended to rise and could not penetrate the metal, immediately pushed the vessels up, and they carried the man with them. . . . When he had risen to the moon, . . . he promptly untied the vessels which he had bound as wings to his shoulders, and did it with such success that he had just reached the lunar air, four toises above the moon, when he took leave of his flippers. The elevation was still great enough for him to have been considerably hurt, if the wind had not inflated the voluminous folds of his robe, and gently sustained him till he set foot on the ground."

In 1760 another dreamer, Tiphaigne de La Roche, published under the title of Giphantie, an anagram of his name, a curious little work in which photography is described—in the ultimate state to which it has just been brought—with the reproduction of the colors. Tiphaigne supposes himself transported to the palace of the elementary genii, the chief of whom told him: "You know that the rays of light, reflected from different bodies, form a picture and depict those bodies on all smooth surfaces, like the retina of the eye, water, and ice. The elementary spirits have endeavored to fix those transient images; they have composed a very subtle and viscous matter, quick in drying and hardening, by means of which a picture is made in a wink. They wash a piece of cloth with this matter, and present it to the objects which they desire to depict. The first effect of the varnished cloth is that of a mirror, in which one can see all the bodies, near and distant, of which the light can bring the image. The cloth with its viscous coating holds the images, which the glass can not do. The mirror represents the objects faithfully to you, but retains none; our cloths represent them no less faithfully, but keep them all. The impression of the images is made the instant the cloth receives them. It is taken away at once, and put in a dark place; an hour later, the coating has dried, and you have a picture, all the more precious because no art can imitate the truthfulness of it, and time can not damage it in any way. We take from the purest source, the body of light, the colors which painters extract from different materials, and which time never fails to change. The precision of the design, the variety of the expression, the touches of more or less strength, the gradation of shades, the rules of perspective, are all abandoned to Nature, which, with a sure course that is never false to itself, traces on our cloths the images which are imposed by her on our eyes, and cause us to question whether what we call realities are not other kinds of phantoms imposed upon our sight, hearing, touch, and all the senses at once. The elementary spirit then went into physical details; first on the nature of the adhesive substance which intercepts and holds the rays; then on the difficulties met in preparing and using it; and, lastly, on the part played by light and the dried substance; three problems which I propose to the physicists of our time, and leave to their sagacity."

The function given by Tiphaigne to the elementary spirits suggests that that author had been initiated into the occult sciences, according to which all the substances in nature possess a proper life, a kind of mortal soul, defined by the term elemental, which directs their reciprocal actions.

"There is not a thing in the world, not a blade of grass, over which a spirit does not reign," says the Cabala of the Jews;

"their life has not an eternal principle as its center; at their death, all is at an end with them." According to Paracelsus, "All the elements have a soul and are living. . . . They are not inferior to man, but they differ from him in not having an immortal soul. They are the powers of Nature—that is, it is they that do what we usually attribute to Nature. We may call them beings, but they are not of the race of Adam." A similar doctrine is developed in Madame Blavatsky's Isis Unveiled. The same method of conceiving of the production of physical phenomena has had defenders in the world of positive science, as in the doctrine of monads of Leibnitz; in the anatomical elements of Claude Bernard, who speaks of our bodies as being composed of millions, milliards of minute beings or living individuals of different species, of which those of the same species unite to constitute our tissues, while the tissues join to constitute our organs, and all react upon one another with a harmonious concurrence for a common end;* and in Sir John Herschel, who wrote in the Fortnightly Review, in 1865, that all that has been attributed to atoms, their loves and hates, their attractions and repulsions, according to the primitive laws of their being, becomes intelligible only when we admit the presence of a mental quality in them. Modern scientific theories tend to assume the unity of matter, of a protyle, which forms all substances by different degrees of condensation. Some go still further, and assume that there is no matter in the ordinary sense of the word, but only force and energy. F. Hartman argues that we can change force into matter, and that is what takes place every instant in the human body, as well as in the vegetable and animal world, and we can change matter into force under like conditions. This etheric force, the base of all the others, is what Lord Lytton describes in his romance, The Future Race, as "vril." So these dreams are repeated—to receive, perhaps, possible verifications in future discoveries; and thus old follies may, as Beaumarchais says, in the Marriage of Figaro, become wisdom, "and the fictions of the ancients be transformed into pretty little truths."—*Translated for The Popular Science Monthly from the Revue Scientifique.*

According to calculations by M. L. Niesten, all the asteroids known (now more than 300), if combined into one, would form a body not quite 514 miles in diameter, or less than one twentieth the diameter of the earth; and it would require 8,575 bodies like it to form a planet having the volume of the earth. The largest of the asteroids, Vesta, is 230 miles in diameter, and the smallest, Agatha, four miles and a half. As all of these bodies having considerable size have most probably been discovered, the estimate of the mass of the whole is not likely to be materially affected by the detection of new ones.

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* Revue des Deux Mondes, September 1, 1864.

THE COLORS OF LETTERS.

By DAVID STARR JORDAN.
PRESIDENT OF LELAND STANFORD, JUNIOR, UNIVERSITY.

THERE are certain powers possessed by childhood, which grow weak or disappear with advancing age or wisdom, until at last all recollection of them is lost. One of these is the ability to recognize shades of color in ideas or objects which can have no color at all. Now and then some trace of this power persists through life, and even in connection with some degree of maturity of judgment. It is then looked upon as a mild hallucination, provoking a smile of sympathy or of incredulity, but not regarded by the person himself—still less by his friends—as possessing any value or significance.

Nevertheless, such associations have a degree of psychological interest. A chapter has been devoted to them in Francis Galton's admirable work, Inquiries into Human Faculty; an interesting essay on Word Color has also been very recently published by Prof. Edward Spencer, of Moore's Hill College.* As a supplement to Galton's work, and as a contribution toward the more exact knowledge of the associations in the human mind of color with conceptions with which the idea of color is incongruous, the present paper is written. And as what I have to say is in a large degree subjective, partaking of the nature of a confession, the use of the first person may be pardoned.

In my youth I always associated the idea of color with the letters of the alphabet. In later years the discovery that other people recognized no such coloration came to me as a surprise. The letter R, for example, always calls up the idea of greenness. It is impossible for me to think of R without the thought that it is green. In like manner S is yellow, and X scarlet. The coloration does not seem to lie in the letter itself, as printed or written, but to coexist with the conception which the letter represents. As the letter R comes into my mind, it seems to go, with grass and leaves, into the category of green things. The sound has nothing to do with its apparent coloration, for C soft and C hard are recognized as the same letter and therefore colored alike. The coloration is not affected by the character of the type. It is in the letter itself, regardless of the way in which it may be printed, or of whether it is printed or written at all. The idea has no connection with the lettering in any colored picture books, nor does it arise from any association of that sort.

* Proceedings of the Indiana College Association for 1889, pp. 40–45, published December, 1890.

Words seem to me also more or less definitely colored, but the association of coloration with me arises solely from the letters of which the words are composed. The dominant letters, especially the initial letter, or the letters most conspicuous in pronunciation, give color to the word. Thus Rosalind, though containing but two green letters, has a dominant shade of green, as salvia or silica have of yellow. A pleasing variety in the colors of the letter tends to render a word attractive. Thus the words Vernon, Severn, and Exeter, with contrasted colors, are more attractive than such words as Patton, Hammond, or Armenia, in which the colors are few or not contrasted. This association of color is stronger than that of the names of the colors themselves, for these fail with me instantly to call up the colors they represent. Thus the word red seems decidedly green in its hue, and it seems unnatural to me that so many words beginning with R, as red, roth, rouge, ruber, rufus, and the like, should have come to mean red. The word blue is also largely green, while yellow is very far from the hue indicated by its meaning.

These letter colors seem for the most part not deep or vivid, but suggest transparent shades like the hues of colored stars, and they are often evanescent where the attention is fastened directly on them. The red, for example, is more like that of the planet Mars than that of a flaming torch. The shades of red vary somewhat, from the scarlet of X or Z, in which the colors seem most pronounced, to the reddish brown of *a* or *n*, in which the coloration is less conspicuous.

On the basis of these colors I would make the following classification of the alphabet, placing in each category the most positively colored letters first:

Red,	X, Z, F, E, H, A, N.
Green,	R, L, B, T.
Blue,	V, D, Y, K, W, M, P, Q; the V of a violet shade, the M and P lead-color, the Q almost colorless.
Yellow,	S.
White,	O, C.
Straw-color,	G, U.
Blue-black,	I.

In some cases, as in O, C, G, U, I, J, this supposed coloration is plainly derived from the forms of the letters themselves, the O inclosing most empty space, the I none at all. In some other cases, as E, F, or R, B, W, M, the resemblances of form in the pairs in question may have led to their taking place in the same category, the duller letter taking its place beside the brighter one which it resembles.

Similar associations take place with the numerals, although to me the coloration of figures seems less vivid than that of letters.

1 and 0 (zero) agree with I and O, 2 is red, 3, 6, and 9 more or less greenish, 4 and 5 bluish, following the letter V, 7 orange, and 8 light yellow. I have also tried the Greek alphabet, with a view to testing its possible color associations. I find, however, that I can not separate these letters from their Latin cognates. Theta seems to me as greenish as tau; chi (X) vacillates between C and X, and psi (ψ) is like the ps of which it is composed.

I have also made attempts to find the color relations in the Chinese alphabet, but without much success. I have no childish associations with these letters, and I can imagine color only in those which in some way suggest by their form the letters in the Latin alphabet. Thus 木 (tree) seems greenish like T, and 女 (woman) seems to follow Z or X.

I find that with other persons who confess to similar color associations there is a decided lack of agreement as to the impressions produced by most of the different letters.

My friend, Prof. Edward Spencer, has given me a chromatic alphabet, arranged as follows:

Shining black,	I, E, H, R, T, 1, 3, 4, 6, 7, 9.	Chocolate,	G.
		Light gray,	O, N, X, 5.
Dull black,	F, J, K.	Pale,	D, Z, V.
Brown,	B, M, Q, W.	White,	O.
Golden,	C, 8.	Water-color,	U, Y.
Orange,	S.	Without color,	L, P.

In this category the letters for the most part represent gradations from jet-black to white. We may, however, trace some relation between the supposed colors and either the forms or the sounds of the letters. Except in the color of the vowels I, O, U, and the isolated and emphatic position of S, there is little in common with the list above given by me.

In my own case, although I have no recollections to justify the theory, I feel sure that these associations are due to the bringing together of a childish classification of letters, with childish categories of color. I was, more than most children, interested in the individuality of the letters. I liked to assort them, to play with them, and transpose them to form other words. In like manner I was interested in colors. I had a childish liking for blue above the other colors, as also a meaningless preference for V and D over the other letters. I can, therefore, see how V and D should be associated with blueness. Other letters of pronounced qualities, as R, L, X, Z, came to head other categories, and the letters which I regarded as indifferent took their places next to those which in form or sound or otherwise appeared to the child similar to these.

Dr. Gustaf Karsten, of the University of Indiana, a philologist interested from boyhood in phonetics, recognizes color in the various vowel sounds, but none in the letters themselves. Thus *a* (in

ah) is the most sharply colored—a burning red—and *o* (in *go*) is of a deep blue. These colors Dr. Karsten associates with the use of these vowels as interjections, *ah* having the red hue of interest or surprise, O the blue shade of pity or regret; *a* (in *may*) is greenish, *a* (in *cat*) is yellow, in *law* dark brown; *e* (in *tree*) is white, *i* (in *in*) is grayish, *o* (in *on*) dull violet, *oo* is black, and *u* dusky grayish.

A lady of my acquaintance recognizes color associations only with certain proper names. Thus, with her, Cæsar is crimson, Theodore blue, Lillian white, Mary or May yellow, Ethel and its compounds lavender, Edith heliotrope. Only names of some marked quality seem to have any color at all. Thus John, James, and the like are without this attribute.

In his article on Word Color, already mentioned, Prof. Edward Spencer has given an interesting account of his own associations of color with words. The substance of his observations he has kindly condensed in a letter to me, from which I quote as follows, adding to it two or three suggestive paragraphs from his paper on Word Color:

"It is natural that the first assertion of the experience of double impressions should have been received with incredulity. I have vainly tried for years to find ears attentive to what I honestly believed a real and reasonable experience, and it is now a great satisfaction to me to see the remarkable growth of interest in this class of subjects.

"My own experience with this class of phenomena has been almost entirely confined to the observation of shade and color as being inseparably connected with characters and words. Word color was first observed by me at the age of six years. At the time it suddenly flashed upon my mind that stone was light in color and the word 'rock' was darker, each one quite nearly resembling the color of the article to which the name was applied. Soon after this time the Arabic figure 8 appeared a beautiful golden yellow. Next, when beginning the study of Greek, the letter θ (*theta*) appeared the color of pearl. Since then shade and color have manifested themselves in an ever-increasing list of characters and words, until they are now perceived in most of the letters and in all parts of speech in all the languages with which I have any acquaintance.

"All suggest to the mind an appearance of shade: some being very light; others dark, and others medium. Color is less often distinguished, but when seen it is even clearer than is the degree of shade. Beginning with one color—yellow, seen in 'rock'—the list has slowly increased until it now includes cream, pearl, black, gray, golden brown, orange, light blue, light and dark brown. The last mentioned was first noticed while writing these pages.

"Thought and reason seem to give but little assistance in determining the character of any word. It is, however, noticeable that the more attention that is given to the subject in general, the clearer do all words shine out. These shades and colors are permanent. A word or symbol seems to have a peculiar and individual character which never changes.

"A student of mine, Mr. C. E. Mead, of Ramelton, who had never before heard of the subject, has spent some time examining me and recording the results.

"If one should wish to divide all visible objects into classes on a basis of the lightness or darkness of their shades of color, he would find some manifestly very light, almost white; others very dark, almost black; others would be of intermediate shades. Let him call all that are very light, 1; all that are very dark, 5; then 2, 3, and 4 would indicate intermediate shades. Some objects would easily be seen to belong to certain classes. Others, even with the aid of contemporaneous examination, would be very difficult to locate. It is convenient to divide words into classes upon the same basis, indicating their degrees of shade by numbers, letting 1 represent very light words, 5 very dark ones, and 2, 3, and 4 the intermediate shades.

"A newspaper article containing fifty words was taken, and a number representing the degree of shade was assigned to each. After two weeks, Mr. Mead returned to me the same list of words, and numbers were reassigned. Out of the list, instead of ten, which the law of chance would indicate would be the same, thirty-four were identical. In no case was there a variation of more than one degree. For example, no word which bore number three in the first test was given number one in the last, nor *vice versa*. Colors were assigned to twenty-one out of forty names and characters. Two weeks later the same colors were reassigned to all but one.

"I do not know how these distinctions are made. I am not conscious of obtaining them by application of any rules or principles. When a word is presented, it is felt to be light or dark, black or yellow, and the mind declares it to be such with little thought or delay, and apparently in the same manner as the pitch and quality of musical sounds are judged.

"My own experience has been so vivid and persistent that I could not doubt that there were reason and law as the basis of the matter. Yet I could not and did not expect that a theory of word-color would be able to find credence as the result of my single testimony.

"Whether or not there is any significance in the fact, nearly all who perceive color in words have made the first discovery in early childhood.

"Various theories have been suggested: the association of the emotions with the words which arouse them, the form of the characters, the sound of the pronunciation of the characters or words, the nature of the mechanical production of the sounds.

"I believe that the fairest conclusion of the matter is, that color and shade depend chiefly upon form, but that sound and sense may have some influence. That there is some relation, some analogy which warrants the statement that this word is light and that is dark, I can doubt but little more than that it is appropriate to say that one sound is high, another low.

"Can it be that this association of form and color is an arbitrary product of the imagination? I would believe it myself but for three facts: The phenomena were observed at an age apparently too early for the origination of any such strange and elaborate idea; too early for the development of any theory universally applicable to all words and letters; too early for the dreams of the imagination to remain as the realities of later life. Second, I do not know nor remember of ever having laid down any principles of criticism. Third, I am not conscious of employing any such principles. To do this would require great use of the memory. I have no reason for believing that it is so employed. Indeed, rather than burdening the memory with special facts or general principles, word-color even relieves it of a part of its proper work. It has more than once assisted in the study and use of ancient language vocabularies. For example, only by means of this have I been able to distinguish between *ferus*, fierce, and *ferrum*, iron. When wishing to refer to the place of the former use of a word, its shade is of great service in finding its position on the page. Sometimes by its assistance words are seen to be correctly or incorrectly spelled. How many are there of you who do not write in two ways a word of doubtful spelling, and then choose one for no other reason than that it 'looks right'? Such an act is, perhaps, an unconscious testimony to word-color."

Associations of color with musical tones are not uncommon. Certain musicians claim to play the piano by color. One of my correspondents is positive that there exist definite relations between color and sound. In his view "every person has a key-note, and each key-note corresponds to a color which the person naturally prefers to any other." He claims to be able to indicate a "person's favorite color by knowing this key-note. A fine piece of music may thus be worked into a painting by using the colors corresponding to the musical notes." Conversely I should suppose the colors of the rainbow might be rendered into a musical symphony of perfect harmony.

Not less curious is the occasional association of color with taste. A student tells me that when she was a young girl she

frequently recognized colors in the taste of various articles of food. Sometimes she would say to her mother that this food—otherwise agreeable—"tastes so very yellow that I can not eat it." She was reproached for such eccentric notions, and finally outgrew them. Now she is unable to recall any of these associations, or to remember what substances formerly tasted yellow, and what ones blue or green.

I may close this discussion with a wise observation of Francis Galton: "Persons who have color associations," he says, "are unsparingly critical. To ordinary individuals one of these accounts seems just as wild and lunatic as another, but when the account of one seer is submitted to another seer, who is sure to see the colors in a different way, the latter is scandalized and almost angry at the heresy of the former."

ANIMAL AND PLANT LORE.

By Mrs. FANNY D. BERGEN.

IV.

ACCORDING to popular tradition, a surprising variety of physical ailments or discomforts may be relieved by human saliva, used in compliance with certain explicit rules. Such prescriptions abound both in our own day and in the pseudo-medical literature of earlier ages, varying more or less in different places and in different periods, but here and there to-day we find some interesting survival that tallies exactly with a superstition two thousand or more years old.* Many of these popular prescriptions apparently are based entirely upon supposed curative virtues of human saliva, while others may more properly be said to be directions for working, by means of spittle, spells or charms, that are supposed to cure bodily disorders.

So general do I find to be the belief that human saliva has medical properties, that, desiring to be on the safe side before ranking as out-and-out superstitions many very common customs dependent upon this belief, I have consulted a number of trustworthy medical authorities in regard to the matter. The universal testimony is to the effect that there is not the slightest scientific warrant for any prescriptions in which relief of pain is promised on account of any specific remedial quality of spittle. Warmth and moisture may be grateful to a burn, insect-bite, or

* The present paper, which deals almost entirely with the uses of saliva in folk medicine, forms only a part of a somewhat extended treatment of the subject of American superstitions in regard to saliva which the writer hopes, at some future time, to present in a more permanent form in connection with other folk lore.

otherwise inflamed surface of the cuticle, but warm water would always do all that saliva could do.

One very queer notion which I have found in parts of Pennsylvania, northern Ohio, central Maine, and in Dorchester, Ontario, is that a pain or "stitch" in the side, induced by running or rapid walking, may be cured by lifting a stone, spitting on its under surface, and replacing it. In Chelsea, Mass., children who bring on pain in the side by running say that it may be cured by picking up a small pebble and placing it for a time under the tongue. In Cambridge, school-children in racing or in playing romping games may often be seen to stoop, pick up a pebble, and insert it either under the tongue or under the upper lip to prevent pain in the side. An eleven-year-old boy belonging to a cultivated family, and attending one of the best public schools in Cambridge, assures me that he believes a person could run all day without weariness or pain by adopting this simple precaution. The above-mentioned charm-cures become more interesting when compared with two Swabian beliefs recorded by Dr. Buck. One of these is that palpitation of the heart may be relieved by secretly lifting a stone from the ground, spitting on it three times, and replacing it; while a Swabian cure for toothache is to have the sufferer spit on the under side of a silicious stone.

In eastern Massachusetts and in parts of New Hampshire a very common practice, when one's foot is "asleep," is to cross the top of the benumbed foot with the tip of the fore-finger moistened with saliva. An Italian fruit-vender tells me that this usage is very common among the peasant class in Italy. In Lawrence, Mass., the same thing is done to the hand if it be "asleep." From northern Ohio a variation of the practice is sent me: if the foot or leg be "asleep," to spit on your hand or finger and rub under the knee on the hamstring is said to give quick relief from the unpleasant pricking sensation. An Irish servant-girl in Brooklyn, N. Y., recommended the same remedy. Among the people comprising a small Gaelic community on Cape Breton is found another variation of this remedy—the saliva-charm there used to relieve the discomfort of a foot "asleep" being, if the right foot is the one troubled, to wet the right fore-finger with spittle and rub the right eyebrow; if the left foot be "asleep," to moisten the left fore-finger and rub the left eyebrow. Pliny quotes from Salpe the statement that when any part of the body is "asleep" the numbness may be relieved by spitting into the lap or by touching the upper eyelid with spittle. Pliny also states that a "crick" in the neck may be cured by putting fasting spittle on the right knee with the right hand and on the left knee with the left hand.

The evident relationship between the last two old Roman cures and the Gaelic one above cited suggests an interesting problem for the student of comparative folk lore. Both the Roman and the Cape Breton charm cures may be descendants of some older Aryan superstition, or the Cape Breton one may have been brought to Great Britain by the Roman invaders. But what theory of distribution will account for a custom similar to those just cited, which is very general among the Japanese, a people separated from western Europeans by the whole width of an immense continent, and differing ethnically so far from the Caucasian race?

It naturally happens, from the Japanese national custom of sitting with the feet doubled under on a mat, that one or both legs will become numb. A Japanese scientist has kindly communicated to me the following particulars in regard to the saliva cures for this numbness:

"In the province of Suwo (southwest part of the main island of Japan) a person picks up a piece of straw, wets it with saliva, and then sticks the same on the middle part of his forehead. The piece is left there till it naturally comes off. In Tokio, after a piece of straw is placed on the forehead, as in the above process, a person wets his index-finger, with which he first touches the tip of his nose and then he rapidly moves his finger up toward the forehead (without touching the latter or the straw). This is repeated three times, accompanied by a saying, 'Shibire Kyo ye agare,' which is of course also repeated the same number of times. The phrase means literally, 'Numbness, go up to Kyo.' Kyo is an abbreviation for Kyoto, where our emperors used to live for many centuries till 1868, and which was then the recognized center of Japan. People always spoke of going up to 'Kyoto.' I do not know the origin of the phrase addressed to the numbness, neither do I know its true significance; but one which strikes me as very probable is, that it was meant to entice numbness out of the lower members of the body, as every one was right glad to obey such a command at any time. In the province of Echigo (northwest part of the main island of Japan) I heard that straw is not used, but a cross is drawn on the forehead with a finger wet with saliva."

Since the cross is not one of the emblems of the old Shinto or of the Buddhist religion, the signature of the cross in the last charm is undoubtedly a survival from the introduction of Roman Catholicism into Japan by Jesuit missionaries in the sixteenth century.

Pliny states that a boil may be cured by wetting it three times with fasting spittle. We still find various kindred remedial charms extant in the United States. From a village near Port-

land, Maine, comes the notion that pimples may be removed by moistening with saliva. In central Maine I find the belief that ringworm may be "killed" by moistening the finger in the mouth and rubbing around the diseased spot, taking care to move the finger in the same direction in which the sun moves.

This is only one of many survivals which I have found, in our own time and country, of the old *withershins* superstition, of which I shall treat more fully in another place.

In County Kent, England, W. G. Black says, in his Folk Medicine, there is a belief that a wart may be removed by wetting the fore-finger with saliva and rubbing the wart in the same direction as a passing funeral, meantime repeating, "My wart goes with you." In eastern Massachusetts and in central New York I find the notion that warts may be removed by rubbing them with spittle. A working-woman from Boston tells me that if one rubs a corn with spit upon retiring, four nights in succession, the center will come out of the painful callosity.

We have all seen how involuntarily people moisten a slight burn with saliva. As above suggested, the application of moisture, and consequent evaporation, no doubt afford some relief to the pain of a burn, and if it be on the hand or wrist the quickest and easiest way to moisten the inflamed spot very likely may be to carry it to the mouth; but if the burn be on the arm, and a pail of water be at hand, or a faucet over a kitchen sink, it certainly can not be to save trouble that the finger is wet with saliva and the latter carried to the burn. And yet the latter process is often resorted to even by persons who disclaim any belief in charms or superstitious usages. A Worcestershire charm for a burn, quoted in Black's Folk Medicine, is to keep the burn a secret, spit on the finger, and press it behind the left ear. We frequently see bruises as well as burns treated with saliva. It is almost an instinctive act with many individuals instantly to raise a knuckle that has received a sharp blow to the mouth to moisten it with spittle. Or a mother or nurse often wets her finger with her own saliva and smears with it a bump on a child's head. This suggests an interesting custom found in parts of Japan, of which the Japanese gentleman, above quoted, has told me. "When a child hits his head against a hard object, he at once applies his own saliva on the painful spot to prevent a lump from being formed, repeating, 'This is parent's saliva, this is parent's saliva,' thus showing the reverent belief in the efficacy of his parent's saliva."

The application of saliva to sore or inflamed eyes is in accordance with a widely distributed superstition. I have myself known several persons in Massachusetts, of considerable education and great refinement, who faithfully resorted to this popular mode of treatment in slight ailments of the eye. In Woburn, Mass., the

confervaceous vegetation, commonly found floating on the surface of pools and sluggish streams, and known by the vulgar name of "frog-spit," is used as an application for inflamed eyes, no doubt in the full belief that, as a kind of spittle, it possesses all the healing powers of that substance. I remember, when a child, in northern Ohio, hearing older people say that sore eyes could usually be cured by anointing them with spittle upon awakening for three mornings in succession. Among the Gaelic community on Cape Breton, above mentioned, I find that a popular cure either for a sty or for ophthalmia is to wet one or both eyes, as the case may be, for nine mornings in succession with fasting saliva. Dr. Buck reports that the Swabians also believe in the efficacy of fasting spittle for sore eyes; and our never-failing Pliny records the Roman belief that ophthalmia may be cured by anointing the eyes every morning with fasting spittle. From Black's Folk Medicine I quote: "Hilarion cured a (blind) woman in Egypt by spitting on her eyes. Vespasian so cured a blind man of Alexandria." Many other examples could be quoted to show the general occurrence of this mode of treatment of disorders of the eyes, both in earlier times and at the present day. It will be noticed that in a majority of the instances just mentioned it is *morning* or *fasting* spittle that is recommended to be used in order to accomplish a cure. A belief in the specific qualities of fasting spittle ranges far and wide. Besides the general recommendation of morning or fasting saliva for ophthalmia, Pliny states that the Romans generally considered that a woman's fasting spittle was highly efficacious for bloodshot eyes. If the woman had abstained from food and wine the day before, better results were to be expected. Scot, in the Discoverie of Witchcraft, records an accredited method "To heale the kings or queenes evill, or any other sorenesse in the throte: Let a virgine, fasting, laie hir hand on the sore and saie: Apollo denieth that the heate of the plague can increase where a naked virgine quenchith it, and spet three times upon it." Fasting spittle is popularly supposed to have both curative and poisonous properties. Black quotes the following from a correspondent: "Two old-fashioned ladies we know (they are Scotch, by the way) hold firmly to the belief that it is very hurtful to swallow the saliva that is in the mouth on first waking. They would not do it on any account." In Madagascar the first spittle in the morning is called "bitter or disagreeable" saliva, and it is thought to have medicinal virtue in healing diseases either of the ear or of the eye.

It is a very common habit throughout the United States and New Brunswick to moisten a mosquito-bite, a slight bee-sting, or the bite of a fly or other insect with saliva. Dr. Buck says that the Swabians also treat fly and bee stings with saliva, morning or

fasting saliva being esteemed most efficacious. This popular mode of alleviating the pain caused by the injection of the usually acid secretion of insects is no doubt often made use of as being the easiest or most convenient way to moisten and cool the smart, and if the wound be instantly sucked with the lips, very likely the poison may be in part withdrawn and relief thus obtained; but I am convinced, as the result of a good many inquiries among people of various occupations and nationalities, that there is a popular belief that human saliva is effective in palliating irritating bites or stings of insects. It would not, perhaps, be easy to prove, but I strongly suspect that there is some historical relationship between our common custom of moistening such stings with saliva and an ancient belief that human saliva had power to antidote many animal poisons, and by its mere contact to destroy serpents and various other dreaded and repulsive creatures. A few superstitions that I have found show that this old belief still survives. In a previous paper I mentioned the New England notion that if a snake should spit into a person's mouth it would surely kill the latter; and now from Maine comes the converse of that superstition, viz., that if a human being spit into a snake's mouth the reptile will quickly die. Quaint old Sir Thomas Browne, in his Vulgar Errors, a book remarkable for the exposure of so many fallacies current in the age in which it was written, expresses a doubt, founded on experience, "as to whether the fasting spittle of man be poison unto Snakes and Vipers," thus showing that this was an old English belief. Pliny recommends fasting saliva as a preservative against the poison of serpents; and in another place he writes: "But the fact is that all men possess in their bodies a poison which acts upon serpents, and the human saliva, it is said, makes them take to flight as though they had been touched with boiling water. The same substance, it is said, destroys them the moment it enters their throat, and more particularly so if it should happen to be the saliva of a man who is fasting." Pliny cites Marcion of Smyrna as authority for the statement that the sea-scolopendra will burst asunder if spit upon, and that the same is true of frogs and "bramble-frogs." Human saliva is popularly believed by the Japanese of to-day to be a deadly poison to centipedes. W. G. Black says that Galen believed that a scorpion could be killed by a person's spitting. A gentleman whose childhood was spent near London, Canada, recalls a superstition of that neighborhood to the effect that if one should spit on a toad's back the creature would split open, precisely the same as the belief which Pliny quotes from Marcion, save that in the Canadian form of the fable the toad takes the place of the frog. In the same locality in Canada children held that if a toad should spit on a person warts would be the result, and this notion is

to be met with in various parts of New England. This is only one of many outgrowths of the old superstition regarding the "venom" of the toad. The Swabian folk medicine, according to Dr. Buck, credits toad-spittle with being very poisonous, and mere contact with a toad is said to cause a limb to swell, especially if the animal has first been made angry. Levinus Lemnius speaks decidedly of the poisonous character of these really harmless creatures; but it is needless to multiply quotations to show how general has been the belief that toads and all pertaining to them were poisonous to man.

Occurring in great abundance in summer upon the young shoots of many plants, and especially upon the culms of grasses, the little flecks of froth in which are concealed the pupa of the frog-hoppers or spittle insects (*Cercopidæ*) are not popularly known to be the exudation of an insect, but are supposed to be the spittle of some animal, and hence the substance has received a variety of common names. I find the name "toad-spit" given to this exudation in eastern Massachusetts, parts of Maine and northern New Brunswick, and the same name is applied to it in parts of England and in the Isle of Jersey. In Jersey the old notion of the toad's venomous character obtains and its spittle is thought to be poisonous, "to poison the blood," as the peasants say; so of course the "toad-spit" upon the plants, being thought to be veritable saliva of toads, is avoided. A woman from Bathurst, New Brunswick, tells me that the so-called toad-spit is frequently found on wild strawberry plants, and the berry-pickers are careful not to gather any fruit on which is to be seen any of this much-feared pseudo-spittle, for, as she says, "you know the berries would be rank poison, for toads are very poisonous; they take all the poison out of whatever they touch. If they are in a well, they suck up all the poison out of the water, and so, when they spit, of course, this poison will be in their spit." In Reading, Mass., the exudation of the tiny creature, lurking unsuspected, within its frothy covering, is called either toad-spit or snake-spit, and bare-footed children fear to let it touch their feet, as the saying is that it will blister the skin. Snake-spit is the name applied to the excretion in many other localities in New England. In Ipswich, Mass., children say that if you make a wish and then break off a certain number—twenty-five, I believe—of grass-stalks without losing the snake-spit on any one of them, your wish will surely come true. In parts of the Maritime Provinces of Canada and in Staffordshire, England, frog-spit is another name for the foamy masses. When a child, in northern Ohio, I remember to have often seen the grasses along the roadside besprinkled with the spit-like substance. I never heard any one speak of it, and I carelessly concluded that it was blown upon the grass by passing horses

that had the "slobbers," as the farmers there say. But I am told that on the north coast of Prince Edward's Island the name "horse-spit" is one in common use for the substance; frog-spit and cuckoo-spit are other synonyms in the same locality. This last fanciful name is also to be met with in England and Ireland. A native of County Kerry, Ireland, has told me in considerable detail the popular theory, in that region, of its origin. The cuckoo-spit, she said, is found only on the leaves of sorrel (*Rumex acetosella*). Any one who looks inside the little bunches of spit will find a very small green bug, and this bug is the last thing the cuckoo ate before she went away for the winter. So, when she comes back, she must spit this out before she can sing at all. And therefore, when people see this spit on the sorrel leaves in the morning, they say, "Now the cuckoo's come back again," or "The cuckoo's been here in the night."

Very generally throughout the United States the spittle of an angry dog, if introduced into the circulation, is thought to be a deadly poison, and the bite of a dog that is enraged is feared almost like that of one having hydrophobia. The same belief is held to a less extent regarding the saliva of an angry man. In Swabia, says Dr. Buck, not only are both of these kinds of spittle deemed to be highly poisonous, but the most dangerous of all is reckoned to be that of a person who has been tickled to death! Some interesting superstitions brought here by Irish immigrants, concerning the dangerous character of the spit of the weasel, have been recounted elsewhere.* With us the saliva of an angry horse is also dreaded. The saliva of the rat, both in the United States and in England, is pretty generally endowed by the popular imagination with venomous properties, whether the rat which inflicts the bite is especially irritated at the moment of biting or not. In the rat's case the poisonous character attributed to the bites of the long, chisel-shaped incisors is sometimes ascribed to a specific poison existent in the saliva, and sometimes to the teeth being covered, as it is thought, with the remains of the garbage on which the animal feeds. Frank Buckland, one of the best of authorities on such matters, asserts positively that the bite of the rat is not poisonous, and that bad effects follow from rat-bites only when the patient's system is in such a condition that any trivial wound might cause serious consequences.† Several skilled physicians, to whom I have addressed inquiries in regard to the nature of wounds inflicted by the teeth, either of man or of such domesticated mammals as are likely to attack man, have all stated that, contrary to the popular belief, these bites are no more dangerous than like injuries inflicted

* Article III of this series.

† Curiosities of Natural History, popular edition, first series, fifth edition, pp. 107, 108.

by other weapons than the teeth. It is true that the bite of certain animals—a squirrel, for example—often suppurates and heals very slowly, but this is to be ascribed to the depth and laceration of the punctures inflicted by its powerful teeth, which are usually made to meet in the finger of the person bitten. Of course, in what precedes, it has been assumed that the animal which inflicted the bite was not rabid. There is a rather wide-spread belief among uneducated people that, if any one is bitten by a dog, the latter should at once be killed, lest at some future time he go mad, when the person bitten would also become rabid. This baseless fear seems also to be common in Ireland, according, to Lady Wilde.

Equally irrational with the general ascription of hurtful powers to mammalian saliva is the popular belief in its healing powers. Not only is it usual to hear people say that the dog, for instance, in licking his wounded paw, is making a most efficient vulnerary application, but the dog is encouraged to lick the hand of his master to cure a cut finger or other slight injury. No doubt the cleansing effect of constant licking would be most salutary and would promote healing by the first intention, but in the popular mind a specific healing virtue is attached to dogs' and to cats' saliva—a virtue which is, however, purely imaginary.

Would it be premature to suggest, as a provisional explanation of many saliva cures, especially those of a surgical character, that they are survivals of primeval surgery; and that this, in turn, had its origin in our inheritance from the lower animals, which so often apply saliva to wounds and ulcers by lapping them with the tongue?

But to trace in detail the genealogy of saliva cures and saliva charms is a task as yet impossible. It would surely not be easy even to show how the Mandingo negroes, the South Sea islanders, the American Indians, and the Japanese have come to share with the Aryan and Semitic races in beliefs concerning the magical efficacy of saliva.* For the solution of such problems as this the young science of folk lore must wait, on the one hand, for a general advance in the field of anthropology, and, on the other, for the accumulation and collation of data exceeding a hundred-fold those accessible to the folk-lore student of to-day.

DATA collected in Switzerland by Mlle. N. Iwanoff go to show that mortality from organic disease of the heart decreases as the altitude of the habitation rises. As a secondary result of the inquiry, it was found that this mortality is higher in towns than in the country.

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* Some details in regard to the geographical and ethnical distribution of certain saliva charms were given in a paper of mine, Some Saliva Charms, read before the American Folk-lore Society, at its Philadelphia meeting, November, 1889.

HÖFFDING'S OUTLINES OF PSYCHOLOGY.*

THE translation of Höffding's Psychology which is now offered to English readers is not from the original Danish, but from the German translation. Dr. Höffding has, however, taken a cordial interest in the preparation of the English edition, and accepts it as adequately representing the original. The work contains seven chapters, of which the first four are general and introductory. Chapter I, on the Subject and Method of Psychology, shows that the author is in close sympathy with the English school in making analysis precede synthetic speculation. And in this connection we noted with interest a marginal reference to another work of Prof. Höffding, that on The English Philosophy of our Times (Copenhagen, 1874; German translation, 1889). We have consequently given much heed to his occasional remarks upon the contrast between the German and English schools, of which we give the following as examples:

> The English school devotes attention rather to the elementary real side of conscious life, to the manner in which the mental structure is raised by the combination of fundamental elements; the German school, on the contrary, attends more to the connection and unity which from beginning to end are the marks of consciousness. . . . German psychology has often exhibited a tendency to approach metaphysics; English psychology, on the other hand, has approached the mechanical sciences, and has transferred analogies from them to the conception of mental phenomena.

Chapter II treats of Mind and Body; Chapter III, of the Conscious and Unconscious; Chapter IV is a short one on the Classification of the Psychological Elements; and the remainder of the volume contains three long chapters on the Psychology of Cognition, the Psychology of Feeling, and the Psychology of the Will. His evident familiarity with all the schools of philosophy and with the evolution of mental science in all times and countries gives a characteristic breadth and adequacy to his views upon disputed questions.

In his chapter upon Mind and Body Prof. Höffding discusses the relation between these two different provinces of experience. Using the word mind in the sense of consciousness—as a collective term for sensations, thoughts, feelings, and resolutions—he asks what experience teaches as to the connection of consciousness with that other province of experience whose content is what moves in space. His standpoint is purely *empirical* or *phenomenal*. He

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* Outlines of Psychology. By Harold Höffding, Professor at the University of Copenhagen. Translated by Mary E. Lowndes. London and New York: Macmillan & Co., 1891. 375 pages, small octavo. Price, $1.50.

regards the subject from the psychological and not from the metaphysical point of view. It is with him a question of science rather than of philosophy, and this circumstance gives especial interest to his views. We have had abundant philosophical disquisition upon this subject, and it is refreshing to be told by a man of science just how the case stands as a matter of knowledge.

Although psychology is not a part of philosophy, yet Prof. Höffding teaches that philosophical thought, as a form of mental activity, lies within the sphere of its observation. Without making any assertions about the absolute nature of mental life, or whether such a nature exists, psychology can bring a knowledge of mental phenomena, of their mutual relations and their laws of development, as a contribution to the general conception of the universe; and such a conception, framed in accordance with experience, should be able to clear the point of view and to correct many prejudices.

In treating of the Interrelation of Mind and Body, Prof. Höffding accordingly examines briefly, but with care and penetration, the hypotheses that have been framed to explain the connection between conscious life and the life of the brain. He proceeds entirely from the point of view of experiential psychology, and with no reference to a final philosophy—believing that we only reach the metaphysical point of view when experience has been thoroughly explored and its tendencies have been determined.

We give the following extended extract from Prof. Höffding's work, both on account of its intrinsic interest and as an example of his style and mode of treating the subject. Allowing due weight to all the facts brought forward concerning the relations of mind and body, he says: "Only four possibilities can be conceived: (*a*) either consciousness and brain, mind and body, act one upon the other as two distinct beings or substances (dualism); (*b*) or mind is only a from or a product of the body (materialism); (*c*) or the body is only a form or a product of one or several mental beings (idealism or monistic spiritualism); (*d*) or, finally, mind and body, consciousness and brain, are evolved as different forms of expression of one and the same being." In examining these several possibilities Prof. Höffding repeats that, whichever we may prefer, we can adopt it only as a provisional hypothesis and not as a final philosophical or metaphysical theory; our only concern being to learn what is the view of experiential science.

He enters upon the subject of dualism by asking: "Does an excitation of a sense-organ, when transmitted to the brain, pass into sensation? Does our will set the body in motion? What is the relation between states of consciousness and brain processes? The ordinary notion is that the mind acts upon the body and the body upon the mind." He has elsewhere sagely remarked that

the popular mode of apprehension is distinguished from the scientific in being a compound of experience and metaphysics, and we have here such an instance. But his own clear and guarded statement is as follows:

That we feel this immediately seems to be contradicted by the want of agreement as to the existence of a mind distinct from the body, and by the fact that it is only indirectly that we have come to know with which part of the body the mind is more particularly connected. We can not maintain that the bodily process causes the mental process, because the bodily process (the state of brain connected with sensation) does not itself become an object of consciousness. And if physiology could give a scientific explanation of the condition of the brain that ensues when I am struck by a stone, the feeling of pain aroused in me would not be included in the physiological explanation. Physiology explains a material process by means of other material processes. Its assumptions can not include a case in which one member of the causal relation shall be spatial and the other non-spatial.

Nor does the doctrine of the persistence of energy support the idea of a causal relation between the mental and material. "The doctrine of the persistence of energy is a purely *physical* doctrine. Such an extension would imply the possibility of finding a common measure for the mental and material. Now, what denominator is common to a thought and a material movement, or what common form serves for both? Until such a common form can be pointed out, all talk about an interaction between the mental and material is, from a scientific point of view, unjustified. So long as we confine ourselves to the material we are on safe ground, and so long as we confine ourselves to the mental we are on safe ground; but any attempt to represent a transition from physical to psychological laws, or conversely, brings us face to face with the inconceivable. The causal concept can not be employed to connect two factors which have no common measure. Again:

"If the relation between mind and body, or consciousness and brain, is a causal relation, there must be a difference of time between the process in the brain and the act of consciousness. This, however, is contrary to the view suggested by physiology. The aim of modern physiology is to conceive all organic processes as physical or chemical. Where it has attained to a comprehension of anything in the region of organic life, this has *in every case* been by the tracing back of organic phenomena to physical and chemical laws. If, then, there is a transition from physiological function to psychological activity, from body to mind, physiology, at any rate, working with its present method, can not discover it. . . . So far as we can speak of final results in the physiology of the brain, it is represented as a republic of nerve-centers, each with its function and all in interaction; but there is nothing to indicate the possibility of the physiological process breaking off at any point to pass into a process of a wholly different kind." But in framing our hypotheses we may not enter into conflict with leading scientific principles. "And, in modern natural science, the doctrine of energy is such a leading principle. If, therefore, an hypothesis is in conflict with such a doctrine, the fact tells at once decidedly against it."

Here follows a brief account of the doctrine of interaction as it appeared in the writings of Descartes, who, it is said, gave clear and distinct form to the current doctrine which helped greatly to lay bare its weak points. "To Descartes, therefore, belongs the credit of having set the problem of the relation of mind and body. For to the current notion in its vaguer form there is no difficulty in this relation. With legitimate heedlessness, the practical usage of speech ignores theoretical difficulties. Ordinary language no more regards the fact that physiology and psychology are opposed to the notion of brain and consciousness acting on one another than it respects the doubt of Copernicus as to the sun really moving round the earth. Moreover, the practical usage of speech has been formed under the influence of a partly spiritualistic, partly materialistic metaphysics."

Materialism.—The case is made clearer when one of these two factors is, without more ado, struck out.

> And since the perception of the external material world takes the leading part in our ordinary ideas, while our inner self-consciousness is with difficulty educated to a like clearness and distinctness, it is perhaps the most natural thing to identify materiality with reality, and to conceive of the mental as an effect of the material. Modern materialism usually treats the mental as a function of the material. It has found a solid basis in the doctrine of the persistence of matter and energy and in that of physiological continuity. As a method of natural science it is unanswerable. But it is another affair when the method is converted into a system. It has a perfect right to treat all changes and functions of the organism, and in particular of the brain, as material; but it goes further when it maintains that the phenomena of consciousness are only changes and functions of the brain, and in this consists its encroachment.

Prof. Höffding alludes to the position of Carl Vogt, who in his time gave great offense by declaring that "as contraction is the function of muscles, and as the kidneys secrete urine, so, and in the same way, does the brain generate thoughts, movements, and feelings." In Vogt's comparison, "doubtless the chief emphasis is to be laid on the secreting activity and not on the product. The principle, however, remains the same. Among cautious physiologists with some philosophical training, the doctrine that conscious activity is a function of the brain may be sometimes met with." But the strict physiological use of the term function must contradict such a doctrine. To say that contraction is the function of the muscle, only means that it is a certain form and a certain condition of the muscle in movement. It is just as material when functioning as when at rest. The conception function (in the physiological sense) implies, just as much as the conception matter or product, something presented as an object of intuition in the form of space. But thought and feeling can not be pictured as objects in space, or as movements; we get

to know them, not by external intuition but by self-perception and self-consciousness. That which has not the properties of the material can not be the form of activity of something which is material. Activity of consciousness and cerebral function always come to be known through different sources of experience. The encroachment of materialism consists in the fact that it effaces this essential distinction.

Materialism has never observed that, even if all its assertions are admitted to be just, it yet overlooks something which gives rise to a new and for it a terrible problem—namely, the circumstance that movement in space is known to us only as an object of our consciousness. For the theory of knowledge such notions as consciousness, idea, and intuition lie deeper than such notions as matter and movement. For this reason an absolute and decided materialism was possible only in ancient times, before the awakening of more deeply penetrating philosophical reflection. Democritus is the only consistent materialist. None of the modern materialistic writers can speak with the calm and the certainty with which Lucretius in his majestic verses sets forth the doctrine of Democritus. Modern materialists for the most part confess that, even if we can reduce everything to matter, yet we can not know what matter is in itself. Thus La Mettrie, Holbach, Cabanis, not to speak of the wild and rambling inconsistencies of the most recent writers (Büchner, Moleschott).

But the objection here urged against materialism is not its desire that conscious life shall accept as the only reality something which is given only as an object of consciousness, and can be represented only through the activity of consciousness; but rather that the facts impel us to the result that materialism offends against the conceptions derived from experience itself.

In treating of *monistic spiritualism* as the third possible hypothesis, we must always hold fast the distinction between an empirical and metaphysical way of looking at things. Very many confusions relative to the problem before us are the result of overlooking this distinction. Monistic spiritualism is the view according to which the mind is a mental (*geistige*) substance, and the mental is the only reality; everything material, all movement in space, is but an outer form of a mental life. It is based on the impossibility of explaining the mental by the material, and on the fact, partly overlooked, partly undervalued, by materialism, that our conception of matter is a mental product, and that apart from our conception of it we do not know what matter is. Thus the mental is a presupposition on which all thought rests; and a reasonable hypothesis is formed only by the reduction of the less known to the better known. The mental is properly the only thing fully intelligible to us, for in it we have not only a knowledge of outward circumstances and relations, but a knowledge also of the thing itself. . . .

But, supposing all this to be true, it is not to the point. For, if it be granted that everything is mental, and that nothing exists except thoughts and

ideas, there still remains a distinction between ideas of material movement and ideas of phenomena of consciousness; and thus again arises the problem how these different sets of ideas, which have arisen in accordance with experience, are to be combined. The problem for psychology is empirical, and is independent of the metaphysical. We do not ask whether mind or matter is most fundamental; we inquire in what way mental and material phenomena are connected in that experience which every system of metaphysics consciously or unconsciously presupposes.

The fourth possibility, the *identity* hypothesis, regards the mental and the material worlds as two manifestations of one and the same being, both given in experience.

If it is contrary to the doctrine of persistence of force to suppose a transition from the one province to the other, and if nevertheless the two provinces exist in our experience as distinct, then the two sets of phenomena must be unfolded simultaneously, each according to its own laws; so that for every phenomenon in the world of consciousness there is a corresponding phenomenon in the world of matter, and conversely. The parallels already drawn point directly to such a relation; and it would be an amazing accident if, while the characteristic marks repeated themselves in this way, there were not at the foundation an inner connection. Both the *parallelism* and *proportionality* between the activity of consciousness and cerebral activity point to an *identity* at bottom. The difference which remains in spite of the points of agreement compels us to suppose that one and the same principle has found its expression in a double form. We have no right to take mind and body for two beings in reciprocal interaction. We are, on the contrary, impelled to conceive *the material interaction* between the elements composing the brain and nervous system *as an outer form of the inner ideal unity of consciousness*. What we in our inner experience become conscious of as thought, feeling, and resolution, is thus represented in the material world by certain material processes of the brain, which as such are subject to the law of the persistence of energy, although this law can not be applied to the relation between cerebral and conscious processes. It is as though the same thing were said in two languages. . . .

In the mental as in the material world we hold fast the law of continuity. The *identity* hypothesis regards both these worlds as two manifestations of one and the same being, both given in experience.

The two languages in which the same thought is here expressed, we are not able to trace back to a common original language. So long as we keep strictly to experience, one province is presented as a fragment while the other extends to infinity. The doctrine of the persistence of energy makes the material world into a totality which we can never measure, but in which the fate of the individual forms and elements can be traced. The mental world has no corresponding law to exhibit. Mental elements come and go in experience without our being able to point to an equivalent. The fact that mental states can not be measured like physical energies and chemical substances is, in itself, sufficient to frustrate the hope of our finding a mental parallel to the doctrine of the persistence of force. But, in addition to this, even the fundamental conception of a mental existence puts difficulties in the way. Material existences can pass one into another, so that the energy lost in one is preserved in the other. The doctrine of the persistence of energy shows us the unity and eternity of Nature during the coming and going of all material beings; but mental existence, as has been seen, has for its

fundamental form, memory, synthesis; and synthesis presupposes *individuality*. The material world shows us no real individualities; these are first known from the psychological standpoint, from which inner centers of memory, action, and endurance are discovered. If now we conceive of the individual mental elements (sensations, thoughts, feelings, etc.) as capable of being transposed to other combinations, like chemical atoms, it would follow that they might have an existence apart from a definite individual consciousness—a supposition which our account of consciousness shows to be absurd. Sensations, thoughts, and feelings are mental activities which can not persist when the definite individual connection in which they occur has come to an end. . . .

The theory to which we are here led is not a complete solution of the problem between mind and body. It is only an empirical formula, an indication of the manner in which the relation presents itself provisionally, when, following the hint of experience, we take heed of the close connection between the mental and the material, and the impossibility of a reduction of the one to the other, together with the difficulties attending the notion of a transition from the one to the other. Concerning the inner relation between mind and matter, we teach nothing; we suppose only that one being works in both. But what kind of being is this? Why has it a double form of manifestation; why does not one form suffice? These are questions that lie beyond the realm of our knowledge. Mind and matter appear to us as an irreducible quality, just as subject and object. We therefore postpone the consideration of the question, since it is evident that it lies in reality far deeper than has been usually supposed. But the empirical formula with which we conclude does not exclude a more comprehensive metaphysical hypothesis.

THE QUIANGANES OF LUZON.*

By Prof. F. BLUMENTRITT.

THE Quianganes of Luzon, Philippine Islands, live for the most part in small settlements in the mountain districts; but they have larger colonies in the more level regions, where they can cultivate rice. Their homes are all built after the same type, of wood or reeds, with wooden floors, about twelve feet square, resting about a yard above the earth on posts. They cultivate rice wherever the supply of water will permit it, and, as their land is rarely level, they lay it out in terraces, which they call *pilapil*. If the slope is moderate, they make them of earth; if steep, they strengthen them with walls of stone, the height of which is largely governed by the inclination. Having no plows, they till the soil by main strength with wooden shovels. The watering is very laborious, and sometimes, when in dry seasons the springs fail, their labor is lost. In consideration of the unending vigilance and work exacted by the rice crop, a high value is set upon it.

The men go out to the fields in groups of from six to twenty

* From the missionary report of the Dominican Père Villaverde.

persons, relatives or friends. They work a day for one, a second day for another, and so on, till each one is given his turn—the owner of the field cultivated for the day having to board the whole company. There are also day-laborers who work for the wealthy, and besides their board receive wages in chickens or rice. Their industry is not much developed. Their smiths make of iron axes, lance-heads, knives for cutting rice, and short wood-knives. Their best lance-heads and their *gansas*—a kind of guitar, mounted with bronze and copper—come from the valley of Japao. They make a flute of a reed, which they blow with their nostrils.

The Quianganes recognize the classes of nobles and plebeians. Nobility is a personal character and not hereditary. He is noble who is rich, and among these again those are most eminent who have distinguished themselves as head-hunters; for the Quianganes are a head-hunting tribe. But wealth alone is not sufficient to make any one noble; it is necessary also to go through a certain established ceremonial. The newly rich plebeian who would enter the aristocratic class notifies the people of his own and the neighboring villages of his intention, whereupon a general rejoicing prevails in anticipation of the feasting and drinking that are to come. The finest tree is selected from the wood and felled, and from it is hewn a figure that looks as much as anything else like an animal set erect, from which the legs have been cut off. All the guests work upon this figure, while they are entertained at the expense of the candidate for noble honors. When the statue is finished, it is left lying in the woods, and the company return to their homes. After the end of the field-work, the company go again to the woods for the statue, which is called *Tagabi*, to take it to the candidate's village; a task which is attended by numerous ceremonies. The train joins in a festal march, on which the host strews the road with rice. The transportation of the *Tagabi* is not accomplished in a single day, for the party all go back to their ranches after the first feast; and it is not till the third day that the ceremonial entry of the statue into the village takes place. The figure is deposited under the house of the candidate, and the grand feast follows by which he is received into the caste of the nobles; but to remain there only as long as he is wealthy: wherefore the nobles, to preserve the recognition of their rank, are obliged to give from time to time ocular demonstration of their ability to hold it, by feasting the plebeians and the poor. In this way they often fall into the hands of usurers; and they rarely keep their wealth together long enough to leave it, with its accompanying nobility, to their sons. The sons, nevertheless, even if they have become plebeians, believe that they are honored, and have a special pride in calling themselves sons of nobles.

Old people are greatly esteemed among the Quianganes, chiefly because they can serve as priests and have a special knowledge of religious doctrines and usages. In war, they readily follow the lead of the bravest. Women are highly respected, and, with children, are spared when blood feuds are prosecuted; for the vengeance of the Quianganes is executed only on grown men.

In marriage, the bride is bought from her uncle, or, if she has no uncle, from her brothers or cousins. On the death of his wife, or in case of divorce, the husband must return to her relatives the gifts he has received with her, and a buffalo in addition, especially if he intends to marry again. As he has also to make the usual presents to the relatives of his new bride, and is further expected to provide the wedding feast, a second marriage is a costly affair. Divorces are frequent. With the great irritability of the people, a harsh word is often enough, and the pair go apart. But there is usually a more serious cause than this. Children are spoiled. They are allowed to do as they please, and even to resist their parents, without correction. For a parent to chastise a child insures the condemnation of his tribesmen. In sharp contrast to this extreme neglect of their children is the mutual support of one another by adults. A personal assault demands unconditional blood-vengeance; a scornful word or gesture will not be borne. It is especially dangerous to excite their jealousy in the slightest degree. For this reason intercourse with them is not easy. They are themselves carefully on their guard against hurting the feelings of another, and demand that others shall do the same with them. Blood vengeance is a sacred law with the Quianganes. If one plebeian is killed by another, the matter is settled in a simple manner by killing the murderer or some one of his family who is likewise a plebeian. But if a prominent man or noble is killed by a plebeian, vengeance on the murderer, a mere plebeian, is not enough; the victim of the sin-offering must be an equivalent in rank. Another nobleman must fall for the murdered noble, for their doctrine is, What kind of an equivalent is it to kill some one who is no better than a dog? Hence the family of the slain noble looks around to see if it can not find a relative of the murderer to wreak vengeance upon, who is also a noble; while the murderer himself is ignored. If no noble can be found among his relatives, the family of the murdered man wait patiently till some one of them is received into the noble's caste; then the vendetta is prosecuted, although many years may have elapsed.

When the blood-feud is satisfied a reconciliation of the contending factions takes place. In all the feuds the heads of the murdered champions are cut off and taken home, and the head-hunters celebrate the affair festally. The skulls are fixed to the front of the house.

They believe that the souls of those who die a natural death go to a land called *Kadungayan*, or the northern region, where they dwell, all gathered in a wood in their special trees, which appear as trees in the daytime, but are changed at night into huts like those of the Quianganes; and that these souls have plantations of sweet potatoes and other food-plants, and live on the invisible substance (or souls) of the animals, rice, and other provisions which their friends left behind offer up for them. Those who have committed robbery and murder on earth without justification receive suitable punishment in *Kadungayan*. If a murderer dies a natural death, his soul is pierced in that shadow-land by a resident spirit.

The Quianganes believe that the souls of the departed sometimes return from *Kadungayan* to the members of their families. Bearing upon this is the following story: There once thus came a spirit with his wife to his people, who fed the pair with the finest rice-meal. When this became too expensive to the relatives, they seated the couple in a canoe and turned it toward the mountains of the Mayoyaos, where the spirits landed. The man sat down upon a stone under the shadow of a tree. A bird in the tree dropped some excrement on the head of the spirit, who did not move. There grew from this a great tree which gradually inclosed within itself the whole of the sitting Quiangane. This tree is called *balisé* (it is identical with the banyan); and the Quianganes still make their breech-cloths from its bark. The souls of men who die a violent or sudden death, and the souls of women who die in childbirth, go to the heaven of the gods. By this are meant the stars, particularly the sun.

The feasts of the dead are of two kinds, according as the deceased has died a natural or a violent death. In the former case the survivors spend all their means, and even go in debt, to procure a sufficient number of swine and buffaloes for the spirit, who will have to subsist in *Kadungayan* on the "substances" of the offered beasts. The unburied corpse remains, in a sitting position, underneath the house, for at least three days, while the exhibition is sometimes extended to fifteen days, and even more. The more wealthy and prominent the dead man had been, the longer the feasting and exhibition. But if the man has been killed or has fallen a victim to the head-hunter, only one pig is slaughtered, and it is eaten by the old men of the village. For they say, "Wherefore slaughter beasts, when the dwellers in the sky have no use for them?" Opposed to this is the precept that the substances of the animals which are consumed at the victory-feast of a returned head-hunter will come to the benefit of the souls of those whose heads he has cut off.

The Quianganes say that the souls of the dead do not go at

once to their destination, but abide for some time near the house of death. They climb from rock to rock, and clamber from tree to tree, subsisting upon such stuff as they can gather up, and trying by night to get back into the house. They do this in order, if possible, to possess the person most closely connected with them, or his soul. Thus, for example, the deceased husband wants to take his wife, the wife her husband, the son his parents, etc., into the other world with him. They consequently believe that serious illness is caused by the efforts of a dead relative to entice the soul out of the body.

As soon as the doctor has come into the hut of the sick man a young hen is offered him, which he slaughters in honor of the venerable ruler of the death kingdom of *Kadungayan*. He examines the fowl's entrails and then pronounces his diagnosis, but not before he has made himself acquainted with the condition of the patient, saying something like this: "The soul of the patient, having looked upon his grandfather's (or his son's, etc.) soul, is at such a place. It is necessary, in order to bring him back, to slaughter so many swine and a buffalo," etc. At the same time he takes the guitar already spoken of and makes a terrible racket on it; then declares, "Behold the sick man's soul has taken leave of the soul of his dead grandfather" (or whatever relative it may be) "to return—it is already nearing the patient." If the patient has a turn for the worse, the medicine-man is called a second time, and declares that his soul has gone away again; that it is restrained by this or that spirit; that it seems to be already at home in the other life, or is about to unite with the spirit of the deceased relative. More pigs, more buffaloes, must be killed to move the soul to come back. Many well persons participate in the consumption of the sacrificed animals, and the sacrificing priest manages to convey the lion's share of the meat to his own house. The families of patients often become heavily indebted in consequence of these offerings.

The Quianganes believe in the reality of dreams, particularly if they relate to the life beyond. Thus a sick man told that he dreamed that his soul had gone up to the sky, where it had feasted itself and drunk to intoxication. The other souls, which lived in houses built in the Quiangane style, did the same. He also observed that Quianganes whose heads had been cut off in battle with the Mayoyaos had new heads, but very small ones. The pleasant belief prevails that the "substance" of the wine called *bubud* prepared by them is peculiarly enjoyed by the spirits and demons. The belief furnishes them with convenient excuses for indulgence. The occasions for the most profuse consumption of *bubud* are the beginning of field-work, when cattle according to the means of the farmer are also slaughtered, in cases of illness

as described above, and on the return from a head-hunting expedition. On the last occasion the victor celebrates an imposing feast, at which many animals are slaughtered in honor, not of the victor, but of his victim, whose head, raised up on the point of a lance, is the center of the orgies. The "substance" of the viands consumed on the occasion and of the liquors is good for the soul of the beheaded man, and for that reason the head-hunter is put to the expense of the feast. For the same reason the vengeance-hunting relatives of the murdered man do not disturb the feast, although it would be easy for them to fall upon the stupefied participants and thus easily satisfy their vendetta. Other occasions are the beginning of the rice-harvest; the end of the harvest, when, all the crop having been gathered in, the principal festival occurs; on a special festival of general drunkenness; and as a protection against being struck by lightning—for lightning loves *bubud* beyond measure, and spares those who by their own intoxication consecrate much of the *bubud* substance to it.

The future is divined from the livers of animals. When they apprehend illness or danger from the lance of an enemy, before a journey, or when they hear a bird singing or see a rainbow while working in the field, they kill an animal, in order to ask its liver concerning the future. If the prognostication is unfavorable, another animal is killed, and another, and so on, till an animal is found with a lucky liver.

The Quianganes count on their fingers to ten, and repeat the operation as often as it is necessary. They also use a cord, in which they fix the number by knots. They count the years by harvests, the months by moons. They have no special names for the days of the week, and fix the time of day by the height of the sun.—*Translated for The Popular Science Monthly from Das Ausland.*

ON THE WINGS OF THE WIND.

OF course you know my friend the squirting cucumber. If you don't, that can be only because you've never looked in the right place to find him. On all waste ground outside most southern cities—Nice, Cannes, Florence; Rome, Algiers, Granada; Athens, Palermo, Tunis, where you will—the soil is thickly covered by dark, trailing vines which bear on their branches a queer, hairy, green fruit, much like a common cucumber at that early stage of its existence when we know it best in the commercial form of pickled gherkins. As long as you don't interfere with them, these hairy, green fruits do nothing out of the common in the way of personal aggressiveness. Like the model young lady of the books on etiquette, they don't speak unless they're spoken

to. But if peradventure you chance to brush up against the plant accidentally, or you irritate it of set purpose with your foot or your cane, then, as Mr. Rider Haggard would say, "a strange thing happens": off jumps the little green fruit with a startling bounce, and scatters its juice and pulp and seeds explosively through a hole in the end where the stem joined on to it. The entire central part of the cucumber, in short (answering to the seeds and pulp of a ripe melon), squirt out elastically through the breach in the outer wall, leaving the hollow shell behind as a mere empty windbag.

Naturally, the squirting cucumber knows its own business best, and is not without sufficient reasons of its own for this strange and, to some extent, unmannerly behavior. By its queer trick of squirting, it manages to kill at least two birds with one stone. For, in the first place, the sudden elastic jump of the fruit frightens away browsing animals, such as goats and cattle. Those meditative ruminants are little accustomed to finding shrubs or plants take the aggressive against them; and when they see a fruit that quite literally flies in their faces of its own accord, they hesitate to attack the uncanny vine which bristles with such magical and almost miraculous defenses. Moreover, the juice of the squirting cucumber is bitter and nauseous, and if it gets into the eyes or nostrils of man or beast, it impresses itself on the memory by stinging like red pepper. So the trick of squirting serves in a double way as a protection to the plant against the attacks of herbivorous animals and other enemies.

But that's not all. Even when no enemy is near, the ripe fruits at last drop off of themselves, and scatter their seeds elastically in every direction. This they do simply in order to disseminate their kind in new and unoccupied spots, where the seedlings will root and find an opening in life for themselves. Observe, indeed, that the very word "disseminate" implies a general vague recognition of this principle of plant-life on the part of humanity. It means, etymologically, to scatter seed; and it points to the fact that everywhere in nature seeds are scattered broadcast, infinite pains being taken by the mother-plant for their general diffusion over wide areas of woodland, plain, or prairie.

Let us take as examples a single little set of instances, familiar to everybody, but far commoner in the world at large than the inhabitants of towns are at all aware of: I mean the winged seeds that fly about freely in the air by means of feathery hairs or gossamer, like thistledown and dandelion. Of these winged types we have many hundred varieties in England alone. All the willow-herbs, for example, have such feathery seeds (or rather fruits) to help them on their way through life; and one kind, the beautiful pink rose-bay, flies about so readily, and over such wide spaces of

open country, that the plant is known to farmers in America as fireweed, because it always springs up at once over whole square miles of charred and smoking soil after every devastating forest fire. It travels fast, for it travels like Ariel. In much the same way, the colt'sfoot grows on all new English railway banks, because its winged seeds are wafted everywhere in myriads on the winds of March. All the willows and poplars have also winged seeds; so have the whole vast tribe of hawkweeds, groundsels, ragworts, thistles, fleabanes, cat's-ears, dandelions, and lettuces. Indeed, one may say roughly, there are very few plants of any size or importance in the economy of nature which don't deliberately provide, in one way or another, for the dispersal and dissemination of their fruits or seedlings.

Why is this? Why isn't the plant content just to let its grains or berries drop quietly on to the soil beneath, and there shift for themselves as best they may on their own resources?

The answer is a more profound one than you would at first imagine. Plants discovered the grand principle of the rotation of crops long before man did. The farmer now knows that if he sows wheat or turnips too many years running on the same plot, he "exhausts the soil," as we say—deprives it of certain special mineral or animal constituents needful for that particular crop, and makes the growth of the plant, therefore, feeble or even impossible. To avoid this misfortune, he lets the land lie fallow, or varies his crops from year to year according to a regular and deliberate cycle. Well, natural selection forced the same discovery upon the plants themselves long before the farmer had dreamed of its existence. For plants, being, in the strictest sense, "rooted to the spot," absolutely require that all their needs should be supplied quite locally. Hence, from the very beginning, those plants which scattered their seeds widest throve the best; while those which merely dropped them on the ground under their own shadow, and on soil exhausted by their own previous demands upon it, fared ill in the struggle for life against their more discursive competitors. The result has been that in the long run few species have survived, except those which in one way or another arranged beforehand for the dispersal of their seeds and fruits over fresh and unoccupied areas of plain or hillside.

I don't, of course, by any means intend to assert that seeds always do it by the simple device of wings or feathery projections. Every variety of plan or dodge or expedient has been adopted in turn to secure the self-same end; and, provided only it succeeds in securing it, any variety of them all is equally satisfactory. One might parallel it with the case of hatching birds' eggs. Most birds sit upon their eggs themselves, and supply the necessary warmth from their own bodies. But any alternative plan that

attains the same end does just as well. The felonious cuckoo drops her foundlings unawares in another bird's nest; the ostrich trusts her unhatched offspring to the heat of the burning desert sand; and the Australian brush-turkeys, with vicarious maternal instinct, collect great mounds of decaying and fermenting leaves and rubbish, in which they deposit their eggs to be artificially incubated, as it were, by the slow heat generated in the process of putrefaction. Just in the same way, we shall see in the case of seeds that any method of dispersion will serve the plant's purpose equally well, provided only it succeeds in carrying a few of the young seedlings to a proper place in which they may start fair at last in the struggle for existence.

As in the case of the fertilization of flowers, so in that of the dispersal of seeds, there are two main ways in which the work is effected—by animals and by wind-power. I will not insult the intelligence of the reader at the present time of day by telling him that pollen is usually transferred from blossom to blossom in one or other of these two chief ways—it is carried on the heads or bodies of bees and other honey-seeking insects, or else it is wafted on the wings of the wind to the sensitive surface of a sister-flower. So, too, seeds are for the most part either dispersed by animals or blown about by the breezes of heaven to new situations. These are the two most obvious means of locomotion provided by Nature; and it is curious to see that they have both been utilized almost equally by plants, alike for their pollen and their seeds, just as they have been utilized by man for his own purposes on sea or land, in ship or windmill, or pack-horse, or carriage.

There are two ways in which animals may be employed to disperse seeds—voluntarily and involuntarily. They may be compelled to carry them against their wills; or they may be bribed and cajoled and flattered into doing the plant's work for it in return for some substantial advantage or benefit the plant confers upon them. The first plan is the one adopted by burrs and cleavers. These adhesive fruits are like the man who buttonholes you and won't be shaken off: they are provided with little curved hooks or bent and barbed hairs which catch upon the wool of sheep, the coat of cattle, or the nether integuments of wayfaring humanity, and can't be got rid of without some little difficulty. Most of them, you will find on examination, belong to confirmed hedgerow or woodside plants: they grow among bushes or low scrub, and thickets of gorse or bramble. Now, to such plants as these, it is obviously useful to have adhesive fruits or seeds: for, when sheep or other animals get them caught in their coats, they carry them away to other bushy spots, and there, to get rid of the annoyance caused by the foreign body, scratch them off at once against some holly-bush or blackthorn. You may often find seeds

of this type sticking on thorns as the nucleus of a little matted mass of wool, so left by the sheep in the very spots best adapted for the free growth of their vigorous seedlings.

Even among plants which trust to the involuntary services of animals in dispersing their seeds, a great many varieties of detail may be observed on close inspection. For example, in hound's-tongue and goose-grass, two of the best-known instances among our common English weeds, each little nut is covered with many small hooks, which make it catch on firmly by several points of attachment to passing animals. These are the kinds we human beings of either sex oftenest find clinging to our skirts or trousers after a walk in a rabbit-warren. But in herb-bennet and avens each nut has a single long awn, crooked near the middle with a very peculiar S-shaped joint, which effectually catches on to the wool or hair, but drops at the elbow after a short period of withering. Sometimes, too, the whole fruit is provided with prehensile hooks, while sometimes it is rather the individual seeds themselves that are so accommodated. Oddest of all is the plan followed by the common burdock. Here, an involucre or common cup-shaped receptacle of hooked bracts surrounds an entire head of purple tubular flowers, and each of these flowers produces in time a distinct fruit; but the hooked involucre contains the whole compound mass, and, being pulled off bodily by a stray sheep or dog, effects the transference of the composite lot at once to some fitting place for their germination.

Those plants, on the other hand, which depend rather, like London hospitals, upon the voluntary system, produce that very familiar form of edible capsule which we commonly call in the restricted sense a fruit or berry. In such cases, the seed-vessel is usually swollen and pulpy; it is stored with sweet juices to attract the birds or other animal allies, and it is brightly colored so as to advertise to their eyes the presence of the alluring sugary foodstuff. These instances, however, are now so familiar to everybody that I won't dwell upon them at any length. Even the degenerate school-boy of the present day, much as he has declined from the high standard set forth by Macaulay, knows all about the way the actual seed itself is covered (as in the plum or the cherry) by a hard, stony coat which "resists the action of the gastric juice" (so physiologists put it, with their usual frankness), and thus passes undigested through the body of its swallower. All I will do here, therefore, is to note very briefly that some edible fruits, like the two just mentioned, as well as the apricot, the peach, the nectarine, and the mango, consist of a single seed with its outer covering; in others, as in the raspberry, the blackberry, the cloudberry, and the dewberry, many seeds are massed together, each with a separate edible pulp; in yet others, as in the gooseberry,

the currant, the grape, and the whortleberry, several seeds are imbedded within the fruit in a common pulpy mass; and in others, again, as in the apple, pear, quince, and medlar, they are surrounded by a quantity of spongy edible flesh. Indeed, the variety that prevails among fruits in this respect almost defies classification: for sometimes, as in the mulberry, the separate little fruits of several distinct flowers grow together at last into a common berry; sometimes, as in the fig, the general flower-stalk of several tiny one-seeded blossoms forms the edible part: and sometimes, as in the strawberry, the true little nuts or fruits appear as mere specks or dots on the bloated surface of the swollen and overgrown stem, which forms the luscious morsel dear to the human palate.

Yet in every case it is interesting to observe that, while the seeds which depend for dispersion upon the breeze are easily detached from the parent plant and blown about by every wind of doctrine, the seeds or fruits which depend for their dispersion upon birds or animals always, on the contrary, hang on to their native boughs to the very last, till some unconscious friend pecks them off and devours them. Haws, rose-hips, and holly-berries will wither and wilt on the tree in mild winters, because they can't drop off of themselves without the aid of birds, while the birds are too well supplied with other food to care for them. One of the strangest cases of all, however, is that of the mistletoe, which, living parasitically upon forest-boughs and apple trees, would, of course, be utterly lost if its berries dropped their seeds on to the ground beneath it. To avoid such a misfortune, the mistletoe-berries are filled with an exceedingly viscid and sticky pulp, surrounding the hard little nut-like seeds; and this pulp makes the seeds cling to the bills and feet of various birds which feed upon the fruit, but most particularly of the missel-thrush, who derives his common English name from his devotion to the mistletoe. The birds then carry them away unwittingly to some neighboring tree, and rub them off, when they get uncomfortable, against a forked branch—the exact spot that best suits the young mistletoe for sprouting in. Man, in turn, makes use of the sticky pulp for the manufacture of bird-lime, and so employs against the birds the very qualities which the plant intended as a bribe for their kindly services.

Among seeds that trust for their dispersal to the wind, the commonest, simplest, and least evolved type is that of the ordinary capsule, as in the poppies and campions. At first sight, to be sure, a casual observer might suppose there existed in these cases no recognizable device at all for the dissemination of the seedlings. But you and I, most excellent and discreet reader, are emphatically *not*, of course, mere casual observers. *We* look close, and go to

the very root of things. And when we do so, we see for ourselves at once that almost all capsules open—where? why, at the top, so that the seeds can only be shaken out when there is a high enough wind blowing to sway the stems to and fro with some violence, and scatter the small, black grains inside to a considerable distance. Furthermore, in many instances, of which the common poppy-head is an excellent example, the capsule opens by lateral pores at the top of a flat head—a further precaution which allows the seeds to get out only by a few at a time, after a distinct jerk, and so scatters them pretty evenly, with different winds, over a wide circular space around the mother-plant. Experiment will show how this simple dodge works. Try to shake out the poppy-seed from a ripe poppy-head on the plant as it grows, without breaking the stem or bending it unnaturally, and you will easily see how much force of wind is required in order to put this unobtrusive but very effective mechanism into working order.

The devices of this character employed by various plants for the dispersal of seeds even in ordinary dry capsules are far too numerous for me to describe in full detail, though they form a delightful subject for individual study in any small suburban garden. I will only give one more illustrative case, just to show the sort of point an amateur should always be on the lookout for. There is an extremely common, though inconspicuous, English weed, the mouse-ear chickweed, found everywhere in flower-beds or grass-plots, however small, and noticeable for its quaint little horn-shaped capsules. These have a very odd sort of twist or cock-up in the middle, just above the part where the seeds lie; and they open at the top by ten small teeth, pointed obliquely outward, for no apparent reason. Yet every point has a meaning of its own for all that. The plant is one that lies rather close upon the ground; and the effect of this twist in the capsule is that the seeds, which are relatively heavy, and well stored with nutriment, can never get out at all, unless a very strong wind is blowing, which sweeps over the herbage in long, quick waves, and carries everything it shakes out for great distances before it. So much design have even the smallest weeds put into the mechanism for the dispersion of their precious seeds, the hope of their race and the earnest of their future!

Artillery marks a higher stage than the sling and the stone. Just so, in many plants, a step higher in the evolutionary scale as regards the method of dispersion, the capsule itself bursts open explosively, and scatters its contents to the four winds of heaven. Such plants may be said to discharge their grains on the principle of the bow and arrow. The balsam is a familiar example of this startling mode of moving to fresh fields and pastures new: its capsule consists of five long, straight valves, which break asunder

elastically the moment they are touched, when fully ripe, and shed their seeds on all sides, like so many small bombshells. Our friend the squirting cucumber, which served as the prime text for this present discourse, falls into somewhat the same category, though in other ways it rather resembles the true succulent fruits, and belongs, indeed, to the same family as the melon, the gourd, the pumpkin, and the vegetable-marrow, almost all of which are edible and in every way fruit-like. Among English weeds, the little bittercress that grows on dry walls and hedge-banks forms an excellent example of the same device. Village children love to touch the long, ripe, brown capsules on the top with one timid finger, and then jump away, half laughing, half terrified, when the mild-looking little plant goes off suddenly with a small bang and shoots its grains like a catapult point-blank in their faces.

It is in the tropics, however, that these elastic fruits reach their highest development. There they have to fight, not merely against such small fry as robins, squirrels, and harvest-mice, but against the aggressive parrot, the hard-billed toucan, the persistent lemur, and the inquisitive monkey. Moreover, the elastic fruits of the tropics grow often on spreading forest trees, and must therefore shed their seeds to immense distances if they are to reach comparatively virgin soil, unexhausted by the deep-set roots of the mother-trunk. Under such exceptional circumstances, the tropical examples of these elastic capsules are by no means mere toys to be lightly played with by babes and sucklings. The sand-box tree of the West Indies has large round fruits, containing seeds about as big as an English horsebean; and the capsule explodes, when ripe, with a detonation like a pistol, scattering its contents with as much violence as a shot from an air-gun. It is dangerous to go too near these natural batteries during the shooting season. A blow in the eye from one would blind a man instantly. I well remember the very first night I spent in my own house in Jamaica, where I went to live shortly after the repression of "Governor Eyre's rebellion," as everybody calls it locally. All night long I heard somebody, as I thought, practicing with a revolver in my own back garden; a sound which somewhat alarmed me under those very unstable social conditions. An earthquake about midnight, it is true, diverted my attention temporarily from the recurring shots, but didn't produce the slightest effect upon the supposed rebel's devotion to the improvement of his marksmanship. When morning dawned, however, I found it was only a sand-box tree, and that the shots were nothing more than the explosions of the capsules. As to the wonderful tales told about the Brazilian cannon-ball tree, I can not personally indorse them from original observation, and will not stain this veracious page with any second-

hand quotations from the strange stories of modern scientific Munchausens.

Still higher in the evolutionary scale than the elastic fruits are those airy species which have taken to themselves wings like the eagle, and soar forth upon the free breeze in search of what the Americans describe as "fresh locations." Of this class, the simplest type may be seen in those forest trees, like the maple and the sycamore, whose fruits are flattened out into long expansions or parachutes, technically known as "keys," by whose aid they flutter down obliquely to the ground at a considerable distance. The keys of the sycamore, to take a single instance, when detached from the tree in autumn, fall spirally through the air, owing to the twist of the winged arm, and are carried so far that, as every gardener knows, young sycamore trees rank among the commonest weeds among our plots and flower-beds. A curious variant upon this type is presented by the lime, or linden, whose fruits are in themselves small, wingless nuts; but they are borne in clusters upon a common stalk, which is winged on either side by a large membranous bract. When the nuts are ripe, the whole cluster detaches itself in a body from the branch, and flutters away before the breeze by means of the common parachute, to some spot a hundred yards off or more, where the wind chances to land it.

The topmost place of all in the hierarchy of seed life, it seems to me, is taken by the feathery fruits and seeds which float freely hither and thither wherever the wind may bear them. An immense number of the very highest plants—the aristocrats of the vegetable kingdom, such as the lordly composites, those ultimate products of plant evolution—possess such floating feathery seeds; though here, again, the varieties of detail are too infinite for rapid or popular classification. Indeed, among the composites alone—the thistle and dandelion tribe with downy fruits—I can reckon up more than a hundred and fifty distinct variations of plan among the winged seeds known to me in various parts of Europe. But if I am strong, I am merciful: I will let the public off a hundred and forty-eight of them. My two exceptions shall be John-go-to-bed-at-noon and the hairy hawkweed, both of them common English meadow-plants. The first, and more quaintly named, of the two has little ribbed fruits that end in a long and narrow beak, supporting a radial rib-work of spokes like the frame of an umbrella; and from rib to rib of this framework stretch feathery cross-pieces, continuous all round, so as to make of the whole mechanism a perfect circular parachute, resembling somewhat the web of a geometrical spider. But the hairy hawkweed is still more cunning in its generation; for that clever and cautious weed produces its seeds or fruits in clustered heads, of which the central ones are winged, while the outer are heavy,

squat, and wingless. Thus does the plant make the best of all chances that may happen to open before it; if one lot goes far and fares but ill, the other is pretty sure to score a bull's-eye.

These are only a few selected examples of the infinite dodges employed by enlightened herbs and shrubs to propagate their scions in foreign parts. Many more, equally interesting, must be left undescribed. Only for a single case more can I still find room—that of the subterranean clover, which has been driven by its numerous enemies to take refuge at last in a very remarkable and almost unique mode of protecting its offspring. This particular kind of clover affects smooth and close-cropped hillsides, where the sheep nibble down the grass and other herbage almost as fast as it springs up again. Now, clover seeds resemble their allies of the pea and bean tribe in being exceedingly rich in starch and other valuable foodstuffs. Hence, they are much sought after by the inquiring sheep, which eat them off wherever found, as exceptionally nutritious and dainty morsels. Under these circumstances, the subterranean clover has learned to produce small heads of bloom, pressed close to the ground, in which only the outer flowers are perfect and fertile, while the inner ones are transformed into tiny, wriggling corkscrews. As soon as the fertile flowers have begun to set their seed, by the kind aid of the bees, the whole stem bends downward, automatically, of its own accord; the little corkscrews then worm their way into the turf beneath; and the pods ripen and mature in the actual soil itself, where no prying ewe can poke an inquisitive nose to grub them up and devour them. Cases like this point in certain ways to the absolute high-water-mark of vegetable ingenuity: they go nearest of all in the plant-world to the similitude of conscious animal intelligence.—*Cornhill Magazine.*

SKETCH OF GEORGE CATLIN.

GEORGE CATLIN'S work was not directly scientific, but rather artistic. It was inspired, nevertheless, by a scientific motive; and it has resulted in leaving to the world the fullest and most various records that it has, in picture and written description, of the aboriginal tribes of both Americas, as they were before their customs and ideas were modified by civilization, or they were contaminated by white influences—a most precious collection of original material for future anthropologists to study.

GEORGE CATLIN was born in Wilkesbarre, Pa., July 26, 1796, and died in Jersey City, N. J., December 23, 1872. He was descended from a family who "came over with the Conqueror," his ancestor of that period having been recorded in Domesday Book as possessing in 1087 two knights' fees of land in Kent. The Cat-

lins have been seated ever since at Newington, Kent; and various members of the family have been honorably employed in the service of the kings of England and other powers. Thomas Catlin, the first ancestor in the United States, with two brothers, came from England or Wales some time before 1643, when he is mentioned as having been settled in Hartford, Conn. Putnam Catlin, the artist's father, served in the colonial forces for six years during the Revolutionary War. His mother, Polly Sutton, was the daughter of an early settler of Wyoming Valley, who was engaged in the battles with the Indians at the time of the massacres; and she was herself captured by the Indians at the surrender of Forty Fort.

Mrs. Catlin was a Methodist and a devout Christian; while the father, a practicing lawyer, was "a philosopher, professing no particular creed, but keeping and teaching the commandments." In 1797 the family removed to Ona-qua-qua Valley, Broome County, N. Y., traveling on horseback over an Indian trail, the baby George being carried in his mother's arms. They afterward removed, at different times, to Hop Bottom, Montrose, and Great Bend, Pa.

Until he was about fifteen years old the boy lived much with Nature, and became an accomplished hunter and fisherman—occupations for which he had an inveterate propensity, and from which his father and mother had great difficulty in turning his attention to books. By virtue of his associations his mind and imagination were filled with stories of Indians and Indian life. His parents had vivid recollections of the terrible adventures in which they had participated; his father's generous hospitality caused the place to be frequented by Revolutionary soldiers, Indian fighters, hunters, trappers, and explorers, for whose stories he had an always ready ear; even the noonday rests in the farm-fields were enlivened by the relation of incidents of the early settlement; and the very valley where he lived had been the rendezvous of Brant and his army during the frontier war.

His early training, which was that usual for the sons of persons of means in the colonies, was carefully attended to by his father and his mother. In 1817 and 1818 he attended the law school of Reeves & Gould, at Litchfield, Conn. He continued his law studies in Pennsylvania, and entered upon the practice of the profession in the courts of Luzerne and the adjoining counties. But during the time of his practice, from 1820 to 1823, the passion for painting, in which he had already in Connecticut become noted as an amateur, was getting the advantage of him, and soon all his love of pleading gave way to it; and, he says, "After having covered nearly every inch of the lawyer's table (and even encroached upon the judge's bench) with penknife, pen and ink, and

pencil sketches of judges, juries, and culprits, I very deliberately resolved to convert my law library into paint pots and brushes, and to pursue painting as my future and apparently more agreeable profession." He settled in Philadelphia in 1823, and was at once admitted to the fraternity of artists there, which included Thomas Sully, John Nagle, Charles Wilson, and Rembrandt Peale. In the next year he was admitted as an academician of the Pennsylvania Academy of Fine Arts. He was most successful as a miniature painter in water-colors on ivory. Among his more famous paintings were one of Mrs. Madison in a turban; the Virginia Constitutional Convention of 1839; the portrait of De Witt Clinton, which hangs in the Governor's Room of the New York City Hall, and of which the Franklin Institute, of Rochester, has a copy from his hand; and portraits of members of the Legislature and other prominent men of New York. He visited New York, Buffalo, Norfolk, and other cities in the exercise of his art; and often saw the delegations of Indians that were in the habit of visiting Washington at that period of our history. While in Philadelphia, he writes, his mind was continually reaching for some branch or enterprise of the art "on which to devote a whole lifetime of enthusiasm, . . . a delegation of some ten or fifteen noble and dignified looking Indians from the wilds of the far West suddenly arrived in the city, arrayed and equipped in all of their classic beauty, with shield and helmet, with tunic and manteau, tinted and tasseled off exactly for the painter's palette." Having an eye for nature rather than for the conventionalities of civilization, he had long been of the opinion that the wilderness of our country afforded models equal to those from which the Grecian sculptors transferred inimitable grace and beauty to marble; and a short experience in the woods among Indians confirmed him in this view. In the midst of his success as a painter, he wrote in 1861, "I again resolved to use my art, and so much of the labors of my future life as might be required, in rescuing from oblivion the looks and customs of the vanishing races of native man in America, to which I plainly saw they were hastening before the approach and certain progress of civilization." If he should live to accomplish his design, he thought, "the result of my labors will doubtless be interesting to future eyes, who will have little else left from which to judge of the original inhabitants of this simple race of beings." So he set out alone, unaided, and unadvised, to collect his portraits and illustrations of primitive looks and customs, to set them up "in a gallery, unique and imperishable, for the use and benefit of future ages." He was never even comfortably off in money matters, says his biographer, Mrs. Clara Catlin Clarke, "relying for his livelihood upon his brush or his pen. He lived poor and died the same. He re-

ceived no pecuniary aid, governmental or individual, in the prosecution of his work." He accomplished it with remarkable thoroughness.

He followed this work for forty-two years, from 1829 to 1871, and during that time traveled through the wildernesses of North and South America, and visited Europe, making his name known everywhere. During eight years, from 1829 till 1838, he lived among the Indians, traders, trappers, and hunters of the West.

In 1830 and 1831 he accompanied Governor Clark, Superintendent of Indian Affairs, to treaties held with the Winnebagoes and Menomonees, the Shawnees and Sacs and Foxes, and in these interviews began the series of his Indian paintings. In 1831 he visited, with Governor Clark, the Kansas, and returned to St. Louis. In 1832 he painted the portraits of Black Hawk and his warriors, prisoners of war. In the same year, on his second journey, he ascended the Missouri, by steamer, to Fort Union, mouth of the Yellowstone, and descended the Missouri to St. Louis in a canoe with two men, steering it the whole distance of two thousand miles with his own paddle, visiting and painting ten tribes. Of these tribes the most important were the Mandans, to whom he devoted more time and labor than any other in North America. In 1833 he ascended the Platte to Fort Laramie, visiting villages of the Pawnees, Omahas, and Otoes, and seeing many Arapahoes and Cheyennes, and rode to the shores of the Great Salt Lake, while the Mormons were yet building their temple at Nauvoo. In 1834 he accompanied a regiment of mounted dragoons to the Comanches and other Southwestern tribes, making an extensive journey and seeing many Indians of various tribes; then from Fort Gibson, Ark., on his horse "Charley," without a road or a track, rode to St. Louis, a distance of five hundred and fifty miles, guided by his pocket compass, and swimming the rivers as he met them. In 1835 he ascended the Mississippi to the Falls of St. Anthony, saw the Mississippi Sioux, the Ojibways and Saukees or Sacs, and descended the Mississippi to St. Louis in a bark canoe with one man, steering with his own paddle. In 1836 he made a second visit to the Falls of St. Anthony, steaming from Buffalo to Green Bay, ascending the Fox and descending the Wisconsin Rivers, six hundred miles in a bark canoe to Prairie du Chien, and thence by canoe four hundred and fifty miles to the Falls of St. Anthony. Thence he ascended the St. Peter's to the "Pipestone Quarry" on the Côteau des Prairies, and descended the St. Peter's in a canoe, with a companion, to the Falls of St. Anthony, and from them a second time to St. Louis in a bark canoe, nine hundred miles, steering with his own paddle. In 1837 he went to the coast of Florida to see the Seminoles and Euchees, and in the same years made a voyage from New York to Charleston to paint

Osceola and the other Seminole chiefs, then prisoners of war. The letters embodying the observations made during these journeys—in which thirty-eight tribes sat to him for their portraits—on the tribes and country furnished the illustrations and text for the book, Illustrations of the Manners, Customs, and Condition of the North American Indians, which passed in England through more than twenty-five editions, and of which more than sixty thousand copies were sold.

Mr. Catlin's chief object on these journeys was to observe the Indian as a man, and to perpetuate the representation of the kind of a man he was. He watched him in every aspect, caught him in every mood, studied him in every relation, and put him down, on canvas or in his notes, as he found him. He enjoyed and improved, to the full extent of his power, opportunities which have occurred to few so ready to make a record of them, and will never occur again to any one, of becoming familiar with the red man in his natural, unsophisticated state, with the intention of making mankind, as far as possible, a sharer in his privileges.

Most of the places he visited, the names of many of which have become familiar to us, and which now seem commonplace, were then away out beyond the bounds of civilization, and visited by the ordinary tourist, if visited by him at all, with an apprehension not unlike that with which he would now start out for Central Africa. The Indians knew little of the white man, and his inventions were strange and mysterious to them. Thus, the people on the Yellowstone had never seen or heard of a steamboat, and at some places were at a loss what to do or how to act at the sight of one.

The art of portrait-painting was new to the savages, and the strange, whimsical, and superstitious notions which they conceived of Mr. Catlin's operations were the source of many curious incidents. The portraits produced great excitement in the villages, with intense interest in the personality of the artist. The people pronounced him the greatest medicine-man in the world, for he made living beings; they said "they could see their chiefs alive in two places; those that he had made were a little alive: they could see their eyes move, could see them smile and laugh, and if they could laugh they could certainly speak, if they should try, and they must therefore have some life in them." The squaws generally agreed that "they had discovered life enough in them to render my medicine too great for the Mandans; saying that such an operation could not be performed without taking from the original something which I put in the picture, and they could see it move, could see it stir." Then the cry went around that the artist was a dangerous man; "one who could make living persons by looking at them, and at the same time

could, as a matter of course, destroy life in the same way, if I chose." When a movement was made to expel him from a village, and a council was held about the matter, which sat for several days, he got admittance to their council, and assured them, he says, "that I was but a man like themselves; that my art had no medicine or mystery about it, but could be learned by any of them if they would practice it as long as I had; and that in the country where I lived brave men never allowed their squaws to frighten them with foolish whims and stories. They all immediately arose, shook me by the hand, and dressed themselves for their pictures. After this there was no further difficulty about sitting—all were ready to be painted; the squaws were silent, and my painting-room a continual resort for the chiefs and medicine-men." But Mr. Catlin always noticed that, when a picture was going on, the braves who were assisting kept passing the pipe around, smoking for the success of the picture and the preservation of the sitter. Then he was feasted, a doctor's rattle was presented to him, and a magical wand, or doctor's staff, "strung with claws of the grizzly bear, with hoofs of the antelope, with ermine, with wild sage and bats' wings—and perfumed with the choice and savory odor of the polecat; a dog was sacrificed and hung by the legs over my wigwam, and I was therefore and thereby initiated into the arcana of medicine or mystery."

Mr. Catlin was called by the Iowa Indians *Chip-pe-ho-la;* by the Mandans, *Te-ho-pe-nee Wash-ee,* or Great Medicine White Man; and by the Sioux at Fort Pierre, *Ee-cha-zoo-kah-ga-wa-kou,* the Medicine Painter, and also *We-chash-a-wa-kou,* the Painter. Associating with the Indians almost constantly, and seeing their best side, Mr. Catlin's sympathies were wholly enlisted for them; and we find much in his observations appreciative of their character and revealing an anxious interest in their future. He often speaks as one who felt that a doom of extermination which they did not deserve had been pronounced against them. He wrote an "Indian creed" in 1868, pertinently to his being called "the Indian-loving Catlin," in which he described those people as having always loved him and made him welcome to the best they had; as being honest without laws, having no jails or poor-houses, keeping the commandments without ever having read them or heard them preached from the pulpit, having never taken the name of God in vain, loving their neighbors as themselves, worshiping God without a Bible and believing that God loved them also, and—"I love all people who do the best they can, and oh, how I love a people who don't live for the love of money!" He asserted, in his North American Indians, that the Indian "is everywhere, in his native state, a highly moral and religious being, endowed by his Maker with an intuitive knowl-

edge of some great author of his being and the universe; in dread of whose displeasure he constantly lives, with the apprehension before him of a future state, where he expects to be rewarded or punished, according to the merits he has gained or forfeited in this world." He found him the worshiper of a spiritual God, with no idolatry. He discerned the evil of allowing traders to go among the Indians to corrupt them, and thought that, if they were obliged to come to the settlements to do their trading, they would enjoy the advantages of competition, and see the better features of our civilization. His theories respecting the origin of the Indians do not seem to have taken settled shape. He believed that the primary race did not come here from abroad, but originated here on the soil independently of other races; although wanderers from other lands may have mingled with it. He found reasons for supposing that there may have been a Jewish element in the race, but not that the race was derived from the Jews; and he speculated upon the possible derivation of the Mandans from a Welsh colony under Prince Madoc in the early part of the fourteenth century. There are not many scientific observations in his itineraries. His journal at Fort Gibson, in 1834, contains a notice of the death of Mr. Beyrich, a Prussian botanist, who had made an immense collection of plants, and died at Fort Gibson while engaged in changing and drying them.

Mr. Catlin supported himself in his journeys by painting portraits and by the sale of his books. It was his custom to leave the Indian country in the fall and go in his canoe down to St. Louis or New Orleans. There he would select some place promising good custom and settle himself as a portrait-painter for the winter. His collections having become large enough to form a museum and gallery, he took them to Europe and exhibited them at the principal capitals. His first adventure of this kind was fairly successful, and he returned home with a competence. His visit to France, from 1845 to 1848, led to pecuniary disaster, and was saddened by the loss of his wife and son; and in 1852 he suffered a financial wreck in London, from which he never recovered.

Between 1852 and 1857 Mr. Catlin made three voyages from Paris to South and Central America. He found great difficulty in getting the Indians of the Amazon to sit for their pictures, but by catching them unawares and sketching from his boat while they were detained on the shore by some pretext of entertainment, he was able to make sketches among thirty different tribes, on the Amazon, the Uruguay, the Yucayali, and in the open air of the pampas and llanos, containing many thousand people, in their canoes, at their fishing occupations, and in groups on the river's shore.

After he returned from his South American campaigns, Mr. Catlin lived in Brussels, upon the proceeds of his brush, and there began the preparation of his cartoon collection.

Mr. Catlin died of an illness contracted from an exposure which he suffered in Washington, in October, 1872. He was removed thence to Jersey City, where his daughters and his brother-in-law, the Hon. Dudley S. Gregory, were living. His collection of pictures now belongs to the Smithsonian Institution, and constitutes the George Catlin Indian Gallery of the United States National Museum. In his paintings he sought to represent the truth, and invented nothing. He regarded the domestic and every-day customs, habits, and manners of the Indians as the essentials to the proper study of their origin and descent, and aimed to reproduce them thoroughly. His principal books were Letters and Notes on the Manners, Customs, and Condition of the North American Indians; written during eight years of travel among the wildest tribes of Indians in North America, first published in 1841, and reproduced in several editions, in English and German, with divers variations of title; and Life amongst the Indians, a book for youth, 1867; also published in French. The list also includes works on the O-kee-pa, a religious ceremony of the Mandans; catalogues of his gallery; a pamphlet on breathing with the mouth shut, giving the results of experiences and observations acquired during his life among the Indians, 1865; a pamphlet concerning a Steam Raft suggested as a Means of Security to Human Life on the Ocean, 1850; Last Rambles amongst the Indians of the Rocky Mountains and the Andes, 1868; The Lifted and Subsided Rocks of America, with their Influence on the Oceanic, Atmospheric, and Land Currents, and the Distribution of Races, 1870; a Letter to William Blackman, concerning his life among the aboriginal races of America; and newspaper, review, and magazine notes and articles.

He put forward in 1832 a suggestion for forming a large reservation of public lands to be a nation's park, containing man and beast in all the wildness and freshness of their natural beauty, saying that he would want no better monument than the reputation of having been the founder of such an institution. In 1845 he published a plan for disengaging and floating quarter-decks on steamers and other vessels for the purpose of saving human lives at sea, and proceeded to take out a patent for it, but found afterward that he had been anticipated. In 1842 he was invited to lecture at the Royal Institution in London, and took advantage of the occasion to introduce a subject on which he had long meditated—that of forming a museum of mankind, to contain and perpetuate the looks and manners and history of all the declining and vanishing races of mankind.

EDITOR'S TABLE.

THE NEW JESUITISM AND SOCIAL REFORM.

THE General of the Salvation Army has, without intending it, rendered a very considerable service to society by provoking just the kind of discussion that was most wanted at the present time in regard to the best means of combating the poverty which seems ever to dog the steps of civilization. The "General" was perfectly confident that, if the public would only supply him with sufficient money, he could grapple with the problem as far as the city of London was concerned. His confidence in himself begot confidence in him on the part of others, and sufficient money has been placed in his hands to enable him to set about working out his experiment. But, while a portion of the public has thus proved responsive, another portion has sought to know something more about the "General's" schemes and methods before deciding on giving him support. Every one is probably aware of the position taken up by Prof. Huxley in reference to this matter. Having been consulted by a friend as to whether he would advise the giving of a large sum of money to the "General's" fund, he frankly stated, in a letter to the London Times, that the methods of the Salvation Army did not inspire him with confidence. What he saw was a vast organization centering round Mr. Booth, and obeying his commands with a submission almost as absolute as that rendered by a monk to the head of his order. In Prof. Huxley's opinion the world has seen enough of this kind of thing, and has had sufficient experience of the corruption that such personally-governed corporations naturally undergo. His conclusion, therefore, is that it would not be wise on the part of any one who does not fully believe in Mr. Booth as a spiritual leader and teacher to devote money to a scheme the main result of which would certainly be to increase that individual's personal influence. The objections thus taken on general grounds were found to be fully justified by the special facts which further inquiry revealed. The methods of the "army" were found to be such as an absolute autocracy might be expected to develop. Under such a system policy becomes paramount, and moral principles, if they conflict with policy, must fare as best they may. As Prof. Huxley's letters to the Times have lately been republished in this country, we should recommend those who are interested in the question as to the expediency of trusting to Mr. Booth's army to undertake social work, and of furnishing it with funds for the purpose, to study that question for themselves in the light of the facts which Prof. Huxley brings forward.

Meantime, we protest on broad scientific grounds against the idea of intrusting social work to any organization the methods and principles of which are not open to the fullest criticism, or to one the operations of which are under the absolute control of a single will. Mr. Booth professes that his main object is to save souls. The saving of souls is, in his opinion, bound up with the adoption of a certain theological creed. He really aims, while satisfying material wants, at extending the sway of his own ideas and beliefs. He wants to transform society into a salvation army, and he asks for money to enable him to carry on the work directly and indirectly. Let those assist who believe that it is well for the world that Mr. Booth's ideas should be more widely spread among mankind; but we do not see with what consistency men who hold

that what society lacks is the bread of knowledge and the discipline of firm governmental administration can lend their aid to a scheme which totally subordinates knowledge to dogma, and seeks to solve social difficulties by a kind of *deus ex machina* intervention of a somewhat fanatical and not overscrupulous individual. We do not grudge Mr. Booth the utmost support he can get from persons on the same plane of thought as himself, and who believe that it is a good thing that he should wield an autocratic power over so many thousands of his fellow-men; but we can not believe that those who regard his way of thinking as narrow and unintelligent, and who disapprove of the concentration of unlimited power, however acquired, in the hands of one man, are justified in directly helping to strengthen his organization. It is right, however, that those who fight under the banner of science should note what is going on and be admonished thereby. If the forces of reaction are in motion, the forces of progress should not be inactive. It is time that the whole problem of social reform should be considered in the light of the best knowledge now obtainable. Medical and sanitary science have much to say to it, and so has political economy. History, psychology, and ethics should all be able to throw light upon it, and anthropology might render more or less assistance. One unfortunate result of the undue specialization of scientific study now prevalent is that scientific men are, or feel themselves to be, cut off to a great extent from large questions of every-day life; but here certainly is one of pressing importance which should not be left to ignoramuses and fanatics to solve in their own crude way. We do not hesitate to say that the scientific men of this generation will gravely fail in their duty if they do not collectively strive to bring the improved knowledge of the time to bear on social problems. If we can not be helped to discern all we ought to do, it would be something if we could be led to see what we ought *not* to do. The prominence which a man like "General" Booth is able to achieve is largely due to the abstention from social concerns of men who ought to be able to take a wider and more sober view of the situation than he. There are social problems to be dealt with in this country just as there are in England, though they may not have reached so acute a stage; and we trust it may not be left to the Salvation Army to take up on this side of the Atlantic work which might so much better be coped with by scientifically directed effort.

CHARITY AS A FETICH.

A FETICH is commonly understood to be some inanimate object ignorantly and blindly worshiped as possessing supernatural powers. In the March number of the Westminster Review Mrs. Emily Glade Ellis discusses The Fetich of Charity. The expression is happily chosen. It is hardly too much to say that, with the Christian world in general, charity is little better than a fetich. It is blindly believed in as something that must do good, that must bless both the giver and the receiver. True, this fetich, like other fetiches, often does not do the things that are expected of it, but, on the contrary, seems to take a spiteful pleasure in doing the opposite of what was expected; still, the faith of its worshipers is not shaken. The African savage will sometimes treat his uncomplying fetich to a sound drubbing; but the Christian savage (shall we say?) has a casuistry at his command that enables him at all times to make apologies both for his fetich and for himself. How richly the fetich deserves to be drubbed, or rather, to use a more rational phrase, how strong the case is for discarding it as a fetich, any one may learn from a perusal of Mrs. Ellis's article. Her arraignment of the fetich falls under five heads: "(1) It invites

and creates gross errors of administration. (2) It shifts the duties of the whole community on to the shoulders of a generous minority. (3) It demoralizes those who give. (4) It demoralizes those who receive. (5) It intensifies the very evils it was designed to cure." The facts adduced in support of this indictment are very striking, and, we do not hesitate to say, conclusive. We are glad to notice that this article only purports to be a first installment of a longer discussion. No subject could be more timely, and we trust that the writer and those who with her appreciate the full evil wrought by a misguided sentimentality will persevere in their efforts to enlighten the public, with a view to the overthrow of methods that are so obviously hurtful, and the substitution therefor of a rational dependence on law in the widest sense.

LITERARY NOTICES.

THE AMERICAN RACE: A LINGUISTIC CLASSIFICATION AND ETHNOGRAPHIC DESCRIPTION OF THE NATIVE TRIBES OF NORTH AND SOUTH AMERICA. By DANIEL G. BRINTON. New York: N. D. C. Hodges. Pp. 392. Price, $2.

THIS is the first attempt—Dr. Latham's previous work of nearly forty years having been only partly in that direction—known to the author, at a systematic classification of the whole American race on the basis of language. While the value of physical data, culture, and traditional history is not depreciated, they are in this work constantly made subordinate to relationship as indicated by grammar and lexicography. Dr. Brinton is not alone in recognizing this fact, for the linguistic classification is also employed as the predominant criterion by the Bureau of Ethnology of the United States and the similar departments in the Governments of Canada and Mexico. The grammatical structure of the language is recognized as superior to the lexical elements in deciding on relationship; and this, too, is in agreement with the general opinion of the best scholars. Especial attention is paid to those parts of the continent whose ethnography remains obscure. The various theories of the origin of American man are reviewed. As to the time of his appearance here, the author agrees with most contemporary anthropologists that it was during the Glacial epoch. Too much importance should not be attached to the indications of an extremely early origin afforded by certain finds of human relics on the Pacific slope—for allowance has to be made for the disturbances to which the soil has been subjected in those regions. The hypothesis of an elevation of the bed of the North Atlantic above water during the Glacial period is accepted to account for the access of man to this continent. The physical traits of the American man of to-day are supposed to have been developed since his arrival, and while he was in his first American home, which is supposed, on the evidence of the superior adaptability of even the tropical Indian to a temperate climate, to have been east of the Rocky Mountains and between the receding wall of the continental ice-sheet and the Gulf of Mexico. The physical characteristics of the Indians North and South are found to be subject to considerable variations, but, "on the whole, the race is singularly uniform in its physical traits, and individuals taken from any part of the continent could easily be mistaken for inhabitants of numerous other parts. This uniformity finds one of its explanations in the geographical features of the continent, which are such as to favor migrations in longitude, and thus prevent the diversity which especial conditions of latitude tend to produce." Beyond all other criteria of a race must rank its mental endowments. Judged by accomplished results, rather than supposed endowments, "the American race certainly stands higher than the Australian, the Polynesian, or the African, but does not equal the Asian. No hard-and-fast line of difference in degrees of culture can be drawn between the tribes; and, when closely analyzed, the difference between the highest and the average culture of the race is much less than has usually been taught." America everywhere at the time of discovery is found to have been in the polished stone age. The religious sentiment was awake in all the tribes of the continent, and even the lowest tribes had

myths and propitiatory rites; and there is a singular similarity in these myths. The psychic identity of the Americans is well illustrated in their languages, which are strikingly alike in their logical substructure. The precise number of linguistic stocks in use in America at the discovery has not been made out. The Bureau of Ethnology has defined fifty-nine north of Mexico, forty of which were confined to the narrow strip between the Rocky Mountains and the Pacific. The stocks, including the South American, are divided by Dr. Brinton into five groups —the North Atlantic, the North Pacific, the Central, the South Pacific, and the South Atlantic; and each stock is considered separately.

WOMAN'S WORK IN AMERICA. Edited by ANNIE NATHAN MEYER. New York: Henry Holt & Co. Pp. 457. Price, $1.50.

THIS voluminous record deals with a subject which within the past generation has risen to great interest and importance to both sexes. The volume comprises an editor's preface, an introduction of two pages by Julia Ward Howe, and seventeen chapters, by as many writers (all women), three of them being on the education of women in different sections of the country, while the others deal with different fields of activity into which women have made their way, generally against obstacles. Of the latter fourteen chapters, seven treat of special divisions of woman's work in philanthropy, and the subjects of the other seven are woman in literature, in journalism, in medicine, in the ministry, in law, in the state, and in industry. The editor explains, in answer to the question, which has been asked her, why she has no chapter on woman in marriage, that the book is restricted to fields "in which women, if entrance were not absolutely denied them, were at least not welcomed nor valued." The editor had a perfect right to limit the book as she saw fit, but thus limited it does not fulfill the promise of its title. An exact title would be, The Extension of Woman's Work in America; the present one is a weapon for those who charge inexactness as a characteristic fault of women. The occupations that are omitted, including the one above mentioned, domestic service, teaching, and dressmaking represent the greater part of the work that women do, and others are such as the sex has won some of its proudest laurels in, namely, the fine arts and the stage. Although this record seems to have been limited by a purpose of celebrating triumphs over public opinion, it contains much information, and recounts many noble works. The profession in which woman has won the highest success in spite of the most determined opposition, and hence has the greatest victory to celebrate, is that of medicine. The chapter on this subject is by Mary Putnam Jacobi, M. D. It traces the history of the movement with considerable detail, giving many names and dates, but without permitting the statistical to overshadow the literary features of the essay. The most important division of the volume is the group of occupations included under the general head Woman in Industry. The essay with this title is by Alice H. Rhine; it describes the transfer of spinning, weaving, and knitting from the home to the factory, the change in the labor of seamstresses which the sewing machine introduced, the establishment of exchanges for goods made by women, the participation of women in trades-unions, various State investigations of the work of women, and some of the legislation based on the information thus gathered. It also gives an account of the rise of woman's education in industrial art, the establishment of various organizations to furnish working-women with comfortable living, to protect them from being cheated out of their wages or savings, and to teach them various gainful occupations, and closes with glowing praise of the Knights of Labor and the principles of socialism. Little or nothing is said about saleswomen, or women as stenographers, typewriters, telegraphers, cashiers, book-keepers, Government clerks, canvassers, and teachers of cookery. Miss Rhine calls the sewing-machine a curse, "like all other labor-saving machines"—a delusion which is mostly confined to the uneducated. One quality for which this essay deserves praise is its freedom from useless words. The paper on Woman in Literature, by Helen G. Cone, records much of glorious achievement. It is rather apologetic, assigning lack of advantages and opportunities as the reason why still more women have not succeeded in this

field. This plea gives scant credit for genius to the women who have done well. Many of the essays overrun into the fields that belong to others; most of them contain irrelevant matter or are overdressed with rhetoric and poetical quotations; nursing as a means of support is mixed up with the charitable care of the sick; and there is other evidence of defective arrangement and editing. Taking it altogether, however, the book has a great deal to tell to any one who is interested in "the woman question," and this consists in not only the facts which the writers have set forth, but largely, also, in what the character of the volume unconsciously reveals of woman's intellectual peculiarities, her mode of action in various circumstances, her attitude toward certain questions of the day, etc.

PHYSICAL RELIGION. By F. MAX MÜLLER. London and New York: Longmans, Green & Co. Pp. 410.

THIS volume contains the author's second course of Gifford Lectures, which were delivered before the University of Glasgow in 1890. The first course was chiefly of an introductory character. In it the questions were discussed of the limits of natural religion, the proper method of studying it, and the materials accessible for the study. The principal manifestations of natural religion were found to be physical, anthropological, and psychological. The present course is devoted to the consideration of the first of these aspects. Physical religion is defined as a worship of the powers of Nature. The author finds it most completely developed, in its simplest form, in the India of the Vedas; and this leads to a survey of the Vedic literature, the circumstances of its discovery, and its age. The whole process of deification is laid before our eyes in the greatest fullness and most perspicuity in the Vedas. In the hymns grouped under that name we may trace "the gradual and perfectly intelligible development of the predicate God from out of the simplest perceptions and conceptions which the human mind gained from that objective nature by which man found himself surrounded." The name of *deva*, or God, in Sanskrit, meant originally *bright*, and came to mean God after a long process of evolution. Of the many Devas, or Gods, of the Pantheon of the Veda, Agni, or the God of Fire, is selected for an analysis, by means of which the history may be understood "of that long psychological process which, beginning with the simplest and purely material conceptions, has led the mind to that highest concept of duty which we have inherited, together with our language, as members of the great Aryan, and not of the Semitic family." In the lectures succeeding the introduction of Agni, Prof. Müller discusses the biography of the divinity Agni as divested of his material character; the usefulness of the Vedic religion for a comparative study of other religions; fire as conceived in other religions; the mythological development of Agni; Religion, Myth, and Custom; Other Gods of Nature; and the conclusion to which the whole leads—"that the human mind, such as it is, and unassisted by any miracles except the eternal miracles of nature, did arrive at the concept of God in its highest and purest form, did arrive at some of the fundamental doctrines of our own religion. Whatever 'the impregnable rock of Scripture truth' may be, here we have the 'impregnable rock of eternal and universal truth.' 'There is a God above all other gods,' whatever their names, whatever their concepts may have been in the progress of the ages and in the growth of the human mind. Whoever will ponder on that fact, in all its bearings, will discover in time that a comparative study of the religions of the world has lessons to teach us which the study of no single religion by itself can possibly teach."

APPLETONS' SCHOOL PHYSICS. By JOHN D. QUACKENBOS (Literary Editor) and others. New York: American Book Company. Pp. 544. Price, $1.50.

THIS volume embraces the results of the most recent researches in the several departments of natural philosophy. It is intended to meet a demand for a thoroughly modern text-book on the subject, which shall reflect the most advanced laboratory and pedagogical methods, and at the same time be adapted, in style and matter, for use in the higher grades of our grammar schools, high schools, and academies. In order to secure the best expositions of the several departments of the science, the dif-

ferent sections of the book have been assigned to educators of recognized eminence and skill, especially qualified to deal with the particular topics which are especially given them. Thus, the sections on motion, energy, force, the properties and constitution of matter, solids, liquids, gases, and mechanics proper have been prepared by Prof. S. W. Holman, of the Massachusetts Institute of Technology; those on heat, light, frictional and voltaic electricity, by Prof. Francis E. Nipher, of Washington University, St. Louis; the chapter on sound, by Prof. Alfred M. Mayer, of Stevens Institute; and the sections relating to magnetism and the practical applications of electricity, by Prof. F. B. Crocker, of the Columbia College School of Mines. Among the specific features claimed for the work are the thorough and original treatment of motion, energy, force, and work; and the modern and appliable conception of the nature, transformation, and conservation of energy, and of the relation between energy and force. The book is adapted to students fourteen years old and upward, but, by the omission of certain classes of paragraphs, it may be made comprehensible to younger learners. It has been the aim of the authors not to teach results merely, but to show how these results have been reached, and what practical use is made of them. Precedence is everywhere given to the practical.

THE EVOLUTION OF PHOTOGRAPHY. By JOHN WERGE. London: Piper & Carter and J. Werge. Pp. 312.

ALTHOUGH photography can now claim a literature of its own, the historical aspect of the art has naturally been neglected. Especially in later years has discovery followed upon discovery so closely as to allow little time for retrospection. The rapid introduction of different processes has been followed by numerous treatises on special methods, and manuals on the general practice of the art abound, but the field of reminiscence has been mostly untrodden save by Mr. Werge, who in 1880 published an account of the origin and process of photography. The present volume easily divides itself into three sections: the first containing an outline of the development of photography; the second, a chronological record; and the third, personal recollections. The author marks four periods in the history of the art: the dark ages; the age of publicity; the epoch of collodion triumphant; the epoch of gelatin successful. The dark ages include the time from the thirteenth century to the advent of the daguerreotype. The first three centuries may be justly regarded as very nebulous indeed, without the glimmering of a photographic ray, and marked only by the discovery of the agents that were long afterward employed in producing pictures. Among such may be counted the invention and perfection of the camera obscura and the metallic researches of the early alchemists. The first step toward acquaintance with actinic influence was the observation of the darkening of chloride of silver in the sixteenth century. As chemical knowledge increased, other phenomena were noted; and finally Scheele, the Swedish chemist, experimented with the prism and demonstrated the greater activity of the violet ray. Meanwhile the double achromatic lens had been constructed, and the possibility of sun portraiture was realized. Scientific men essayed the problem, and in 1839 M. Daguerre's process was given to the world by the French Academy. In spite of this official announcement, there seems to be every reason to agree with Mr. Werge that England had preceded France in photographic discovery, as the Rev. J. B. Reade produced ineffaceable pictures upon paper by means of tannin and hyposulphite of soda in 1837.

The next important advance was made by Talbot in demonstrating the latent image to be the basis of photogenic manipulation. The subsequent discovery and solution of gun-cotton made possible the collodion negatives of Archer; and in 1850, a gelatin process was introduced by M. Poitevin. The art then enters upon its marvelous series of developments; the heliochromes of Niepce de St. Victor, photo-engraving on steel, orthochromatic plates, platinotypes, carbon-printing, and gelatin dry plates. As a dutiful daughter of Science, Photography assists in her researches, makes visible the stars, the mechanism of muscular movement, and the progress of disease.

The chronological record given by Mr. Werge contains not only a list of discoveries and inventions pertaining to photography,

but also the bibliography of the art. Some doubt may be justly felt in regard to the dates assigned to the use of iron and glass; a preliminary acquaintance of a thousand years would, however, suffice for the germination of the photographic idea. The recollections and sketches are sprightly, and include many suggestions for artists and amateurs.

THE PHILOSOPHY OF FICTION IN LITERATURE. By DANIEL GREENLEAF THOMPSON. New York and London: Longmans, Green & Co. Pp. 224. Price, $1.50.

THIS essay begins with a survey of the office of fiction in literature, estimates its value in the bearings of scientific teaching, morals, and æsthetics, analyzes the qualities of a novel, seeks for its various sources of interest, discusses its relations to art, morals, and science, and closes with observations on the construction and the criticism of a work of fiction. The first quality, underlying all the others, and most essential, of a work of fiction is, that it be of sufficient interest to cause one to read it through. Many and very different qualities may be combined with this interest. Hence we have discussions of the manner and extent to which science, morals, and æsthetics may enter into its scope, and the rival qualities that give the most pronounced distinctions of schools, of realism and idealism. Under the last category we have the important principle that a fiction is a work of art, and must respect the canons of art; it must appeal to the æsthetic sense, never losing sight of that primal condition of artistic work, the elimination of the disagreeable. This and other precepts teach that, in the matter of "naturalism," now so much talked about, "the 'experimental' method is a means, not an end. We must not make the mistake of supposing that the study of Nature consists only in an enumeration of Nature's phenomena. Nor can we impose upon the world by giving it our sketches and studies as the *finale* of art. The use of 'observation and experiment' is to enable us the better to employ our faculties. . . . 'Naturalism' never must be allowed to limit our creative activity, but only minister unto it, chastening it to enable us to give substance rather than shadow. It must not chain genius down. It must not restrict its selection of subjects, nor must it absolutely control its treatment of them. It may lay the foundation, furnish the brick and stone and mortar, but not the architecture of the building." The author agrees with M. David Sauvageot, that the important service has been performed by realism of inaugurating a reaction against the arbitrary conventions of degenerate classic and of romantic art; and that it has prepared the way for a new and dominating idealism. The conclusion is forced that, while realism could not dispense with creativeness, it is, if rightly understood, of great value in making strong, clear, and life-like the products of creation. Other objects of interest and causes of interest considered as giving popularity and success to the story that brings them before the mind are the exhibition of power; the exhibition of love, which "plays so prominent a part in life, has so dominant an influence on conduct, that its absence as a motive is at once felt by the reader, and the plot from which it is omitted seems very artificial"; the exhibition of social life; and the comic or ludicrous element. Important points to be considered by a story-writer are, that he should understand exactly what he is about when he forms the plan of his tale, and should appreciate how far he is appealing to each of the three great interests in a work of fiction, and how far he may disregard one for the sake of the other.

ANIMAL LIFE AND INTELLIGENCE. By C. LLOYD MORGAN. Boston: Ginn & Co. Pp. 512. Price, $4.

THE primary aim of the author of this book has been the consideration of animal intelligence from the scientific and philosophical point of view. He has endeavored to contribute from the results of several years' study and thought to our deeper knowledge of those mental processes which we may fairly infer from the activities of dumb animals. But so inextricably entwined does the subject of intelligence seem to be with the subject of life, the subject of organic evolution with the subject of mental evolution, and so closely questions of natural selection to be interwoven with questions of habit and instinct, that he has devoted the first part of the volume to a consideration of organic evolution. From this consideration the conclusion is reached that the

diversity of animal life is the result of processes of evolution or continuity of development. This involves adaptation, which has to be conformed to a changing environment. When the change is in the direction of complexity, we have elaboration; when it is in the direction of simplicity, we have degeneration. Continued elaboration, involving a tendency to differentiation that gives rise to individuality, and a tendency to integration giving rise to association, is progress; and this is opposed to degeneration. The factors of evolution are those of origin and guidance. The origin of variations lies in mechanical stresses and chemical or physical influences. Whether these act on the body, and are transmitted by inheritance, or only on the germ, is not decided. It is also debatable whether use and disuse are factors of origin. The almost universally admitted factor in guidance is natural selection. The physiology of the senses and sense-organs of animals is studied as preliminary to the psychical or mental accompaniments of affections of those organs, which are styled explosive disturbances in the brain or other aggregated mass of nerve-cells. In the mental processes of man a distinction is made between perceptual construction, by which we construct an image of an object from the complex of our perceptions of it, and conceptual analysis, by which we isolate particular qualities of it, forming concepts of the isolates. The formation of a conceptual inference or a judgment is regarded as the first stage of reason, and any mental process involving conceptual inference is rational. In contradistinction to this, an intelligent act is an act performed as the outcome of merely perceptual inference. The quality in animals is intelligence; their faculties are only perceptual. In man alone, and in no other animal, it is contended, is the rational faculty thus defined, developed; and that, "among human folk, that process of natural selection which is so potent a factor in the lower reaches of organic life, sinks into insignificance. For him the moral factor becomes one of the very highest importance. He becomes a conscious participator in the evolution of man, in the progress of humanity." But he can never be wholly independent of natural selection, for biological laws still hold true, though moral considerations and the law of duty may modify them; but, however profound the modification by the introduction of newer and higher factors, the older and lower factors are still at work beneath the surface. The relations of mind and the material organism are discussed in the last chapter.

THE THEORY OF LIGHT. By THOMAS PRESTON, M. A. London and New York: Macmillan & Co. Pp. 465. Price, $3.25.

THE history and present condition of the science of optics form the field of this treatise. In his preface the author refers to the difficulty experienced by students of science in obtaining the scattered publications which contain the latest advances in their respective specialties, and states that in no branch of experimental physics is the English student placed at such a disadvantage as in the theory of light. "Influenced by these considerations," he continues, "I have been induced to undertake the present work, with the hope of furnishing the student with an accurate and connected account of the most important optical researches from the earliest times up to the most recent date. I have, however, avoided entering into the more complicated mathematical theories, yet the mathematical theory, in its most elementary form, as well as the experiments on which it is founded, will be found in sufficient detail to enable the student, furnished with the necessary knowledge of higher mathematics, to attack at once with profit the original memoirs and theories recently elaborated by various English and foreign writers." The book gives a few pages to the views of the ancient philosophers, and comes down so far as to include the recent experiments of Prof. Hertz. The divisions of the book, however, are topical rather than historical; thus, the second chapter describes the propagation of light-waves and the composition of vibrations; the rectilinear propagation of light is the subject of the third; and succeeding chapters deal with reflection, refraction, interference, polarization, etc., the topic which concludes the volume being electro-magnetic radiation. The book is supplied with over two hundred diagrams; it is descriptive, not controversial in character, and is adapted to students well advanced in the science.

HEREDITY, HEALTH, AND PERSONAL BEAUTY. By JOHN V. SHOEMAKER, M. D. Philadelphia and London: F. A. Davis. Pp. 422. Price, $2.50.

IN this book the author presents his subjects in a conversational rather than a formal style, and varies the statement of the scientific principles on which every such treatise must rest with practical directions and illustrative incident. The book can be read with pleasure and amusement as well as with instruction; and if sticklers for form object that in some parts it is hardly dignified enough for science, the author may reply that his book conveys useful knowledge which is none the less knowledge or useful because it is so presented as to be entertaining and easy reading. In the first chapters, which deal with evolution, the Law of Life and Growth, Man's Spiritual and Physical Place in Nature, and kindred topics, are discussed. Weissmann's views on the hereditability of acquired faculties are often referred to, with a disposition to dissent from Weissmann and accept the doctrine of hereditability. The source of the beauty of the fair sex, and the effect of environment and training on the physique, are considered; then the elements of grace, with a chapter on the Art of Walking; the care of the skin and the breath; cosmetic art as applied to the face, hands, feet, hair, and teeth; the care of the eye, ear, and nose; food, clothing, and ventilation; the circulation and digestion; and, in the latter chapters, lists of cosmetic articles, medicated soaps, and household remedies are given.

THE DAUGHTER: HER HEALTH, EDUCATION, AND WEDLOCK. By WILLIAM M. CAPP, M. D. Philadelphia and London: F. A. Davis. Pp. 144. Price, $1.

THE matter of this book was written by special request for a young wife whose education on subjects bearing on her prospective duties as a mother had been insufficient. It furnishes suggestions on subjects of general and obvious interest which might be advantageously worked out in daily home life. Its aim is to enable the mother to second more intelligently the efforts of the medical adviser when he comes professionally into the family, and to offer some practical considerations affecting woman in her family relation. The successive sections of the book treat of the care of the infant from the moment of birth; the child, its training and education; the girl at the age of puberty, and the instruction it is proper to give her then; the wife; and general suggestions upon health.

AN INTRODUCTION TO THE STUDY OF PETROLOGY: THE IGNEOUS ROCKS. By FREDERICK H. HATCH, F. G. S. Second edition. New York: Macmillan & Co. Pp. 128. Price, 90 cents.

THE author has undertaken in this little book to describe briefly the mineral constituents and internal structures of the igneous rocks, their mode of occurrence at the surface, and their origin beneath the crust of the earth. After a few pages of introductory matter, he begins the particular descriptions of the rocks, taking them by groups. Each rock receives a paragraph, in which its chemical composition, crystalline form, hardness, and other characteristics are given, and its mode of occurrence is stated. There is also an extended chapter on the classification and description of the igneous rocks, which gives the distribution of each group in the British Isles. The volume contains forty-three illustrations.

CHAPTERS ON THE THEORY AND HISTORY OF BANKING. By CHARLES F. DUNBAR. New York and London: G. P. Putnam's Sons. Pp. 199.

THESE chapters have been prepared under a feeling of the need of some convenient statement of ordinary banking operations, experienced by the writer when lecturing upon banking to a large class of students in political economy. To the chapters devoted to such operations it was found useful to add a series of historical chapters on certain of the great banks and banking systems. Special chapters have also been added on combined reserves, or the system of clearing-house loan certificates, and the Bank of Amsterdam; and the whole has been revised and the notices of current history have been brought down to the present date.

It is hard to speak too highly of the value of *Appalachia*, the periodical and organ of the *Appalachian Mountain Club*. It serves, in one department of geographical science, a similar purpose with the Proceedings of the Royal Geographical Society, and

in an at least equally acceptable manner. Projected with especial reference to promoting the exploration of American mountains, its range has become, without neglecting these, very catholic, and we may now look in it for original studies of mountain structure and scenery and geographical characteristics in all quarters of the world. The second number of Volume VI (December, 1890), for instance, contains accounts of the Ascent of Three Japanese Volcanoes, by W. J. Holland, of the United States Eclipse Expedition, 1887; the Great Smoky Mountains and Thunderhead Peak, by Frank O. Carpenter; the San Juan Mountains, by F. H. Chapin; and An Ascent of Sierra Blanca, by Charles G. Van Brunt. Mr. Holland's and Mr. Chapin's papers are accompanied by illustrations of a high class. W. B. Clark & Co., Boston. Price, 50 cents.

A most welcome aid in the study of English literature, and a charming piece for leisure-hour reading as well, is Sir Philip Sidney's *Defense of Poesy*, otherwise known as *An Apology for Poetry*, which Ginn & Co. publish (price, 90 cents), edited, with introduction and notes, by *Albert S. Cook*. The essay is a masterpiece of English writing, and is replete with noble thoughts expressed in noble style. The apology of fifty-eight pages—hardly too long to be read at a sitting, if one would read fast—is preceded by a sketch of Sidney's life, a discussion of the date of composition and publication, and observations on the author's learning, style, theory of poetry, and followers and imitators, constituting the introduction, and an analysis. The notes give explanations of the allusions in the work and the peculiarities of language and grammar; and are followed by a list of variants in the different editions and an index of proper names.

An edition of the first two extant books of Quintius Curtius (probably the third and fourth books of the original), *Historiarum Alexandri Magni Macedonis*, or Histories of Alexander the Great of Macedon, is published by Ginn & Co. (price, 35 cents), edited for sight-reading by *Harold N. Fowler*. It is intended for the upper classes of preparatory schools and the lower classes of colleges. The editor's principal work has been to supply foot-notes on each page, giving such words and uses of words as the student can not be reasonably expected to be as yet familiar with. In an introduction, Prof. James B. Greenough tells us what sight-reading is, and gives a drill-exercise to teach the student how to proceed to acquire the art. It means to take in the passage and comprehend it without translating it. "A pupil," Prof. Greenough says, "should begin from the start to try to read straight away, as if the language were his own, to see what mental pictures the author meant to present to himself, and only then, if necessary at all, transfer the thought to an English form of expression." This method, he believes, is, in some form or other, consciously or unconsciously, indispensable for any real knowledge of a foreign tongue.

Contributions to the History of the Southwestern Portion of the United States is the fourth substantial volume, besides a number of essays and statements, included in the annual reports which the Archæological Institute of America has published of the work of Mr. *A. F. Bandelier*. It appears as one of the papers of the Hemenway Southwestern Archæological Expedition. The volume includes an introductory sketch of the knowledge which the Spaniards in Mexico possessed of the countries north of the province of New Galicia, previous to the return of Cabeza de Vaca, in 1536; with papers on Cabeza de Vaca and the importance of his wanderings for Spanish explorations toward New Mexico and Arizona; Spanish efforts to penetrate to the north of Sinaloa, between 1536 and 1539; Fray Marcos of Nizza; and the expedition of Piedro de Villazur, from Santa Fé to the banks of the Platte River in 1720. It was the author's plan, treating the history of the Southwest in sections, monographically, to publish papers further on the expeditions of Coronada, Chamuscado, Espejo, and Oñate, but a suspension of the enterprise is at present forced upon him; and he intimates that there is material to be found in Spain which has not yet been examined that would contribute to the completeness of the work.

Mr. H. L. Green, of the *Freethinker's Magazine*, has sent us a bundle of pamphlets on subjects in which freethinkers are interested, or the thought of which is in accord with that of the school described under that name. It includes two pamphlets on Giorda-

no Bruno and his Monument, containing half a dozen papers by as many authors, and representations of the monument as originally designed and as erected; Ingersoll's Centennial Oration on the Declaration of Independence and Memorial Oration on Roscoe Conkling; The Myth of the Great Deluge, by James M. McCann; Church and State; and a statement of What constitutes a Freethinker? by Mr. Green. The last presents several points of interest. Freethinkers, we learn, "have no war with the Bible—they should have no prejudices against it"; but they are disposed to regard it as like other books, and to decline to accept it, on trust, at the value at which Christians hold it. The author contends that his best and safest friend in matters of religion is reason, and holds everything subject to investigation. "But, notwithstanding the freethinker rejects the Christian view of the Bible and religion, he is an earnest advocate of certain views and opinions of his own. He accepts the truth wherever found. For this reason, although he rejects the claim made for the Bible and religion, he accepts whatever is true or good in either."

In *The Death Penalty* (Putnam's Questions of the Day Series, price $1.50) Mr. *Andrew J. Palm* presents, in rather an impassioned manner, the principal objections to capital punishment. He holds that it is essentially cruel; and that justice as well as mercy should make great allowance for human conduct. He puts aside the Bible argument as not bearing upon the relations of capital punishment to society at the present time; dwells upon the capriciousness of juries, the perils of convicting the innocent, and the harshness of treating the insane as if they were criminals; holds up the detestation with which the executioner is regarded as evidence that the death penalty is repulsive to the better feelings of men; shows how inadequate is fear of the death penalty to repress crime; cites "the voice of experience"—of states which have abolished capital punishment—as being on his side; and quotes the opinions of some noted men on the subject. He then pleads for the reformatory theory of treatment; and closes with a chapter on war.

The compact little work on *Mixed Metals or Metallic Alloys*, by *Arthur H. Hiorns* (Macmillan, $1.50), gives the composition and mode of making a great number of alloys, and in some cases describes the apparatus used in producing them. The author, who is principal of the School of Metallurgy in the Birmingham and Midland Institute, states that his book is designed to give practical men and students a more intimate acquaintance with the nature and properties of metals in the alloyed state, as well as with metals in the free state. The first portion deals with the principal chemical elements, and their classification into suitable groups; the refractory materials used in making crucibles and in furnace construction; as well as the properties and uses of various fluxes. "It has been thought advisable to give a brief account of the main properties of the separate metals, and of the effect of certain elements upon them, seeing that commercial metals are not chemically pure substances, and that the presence of the common impurities often produces a characteristic result, which may be a useful guide to the manufacturer in special cases, and assist him to determine the cause of those anomalies which are constantly occurring in practice."

A manual for medical students and physicians, on *The Physical Diagnosis of the Diseases of the Heart and Lungs*, has been published by Dr. *D. M. Cammann* (Putnams, $1.25). Some topics in this field which have especially interested the author, or on which a reasonable difference of opinion exists, have been considered more in detail than is usual in such a work. In particular the author has improved this opportunity to explain at length his modification of the Cammann stethoscope and the binaural hydrophone. The volume contains twenty-two figures.

A great deal of material is compressed into a small compass in the *Lessons in Applied Mechanics*, by *James H. Cotterill* and *John Henry Slade* (Macmillan, $1.25). The volume is a text-book consisting largely of matter contained in a more extended treatise by the senior author. The chapters are grouped under three heads: Part I, The Principle of Work, includes the subjects of motion, friction, work and energy, the operation of simple machines, the direct-acting engine, unbalanced forces, and dynamometers. Part II deals with Strength of Materials and

Structures; and two chapters on Hydraulics constitute Part III. A list of examples follows each chapter, the total number being over 250, and there are 377 diagrams in the text.

Under the title *Cotton Facts*, a compilation of statistics is published by *Alfred B. Shepperson* (New York), relating to the crops, receipts, exports, stocks, home and foreign consumption, visible supply, prices and acreage of cotton for a series of years, and other related matters. The present edition of the book continues to the close of the cotton season of 1889–'90 the statistics contained in previous issues. Besides the tables, there are several special articles in the volume, one being on Cotton Culture in Central Asia, by Henry G. Kittredge, editor of the Journal of Commerce, Boston, and others on the Cotton Caterpillar, and the Cotton Season of 1889–'90.

The purpose carried out in *Christ and Our Country*, by Rev. *John B. Robins* (Farnesworth Bros., Dalton, Ga., 75 cents), is to combat some of the apprehensions expressed in Our Country, by Dr. Josiah Strong, and Modern Cities, by Samuel L. Loomis. The author has strong hope that Christianity will counteract the dangers that these authors discern in immigration, increasing wealth, Romanism, Mormonism, socialism, city life, etc.

A volume of satire in verse, entitled *The Devil's Visit*, has just appeared, without the author's name (Excelsior Publishing House, $1). A marvelous variety of topics is touched upon in this book, ranging from practical politics to the teaching of Greek, and from communism to the deceptions of a woman's toilet. Every reader will find the faults and follies of many people he knows sharply touched up, and, if he only succeeds in skipping the part where his own weaknesses are similarly treated, will doubtless get much enjoyment from the volume.

The American Patent System, by *D. Walter Brown* (the author, New York), is a manual of direction and advice for inventors in regard to obtaining patents, and in correcting and transferring them.

We have received from Brentano's a fancifully got up volume entitled *Gentlemen*, and divided into two parts, treating respectively of dress and "essential customs" for gentlemen. From the former part we learn that the monocle "is worn any time of day," and in the latter we are informed that no gentleman should ask for a lady's picture "without first having met her at least seven times." These quotations sufficiently indicate the nature of the book. (Price $1.50.)

With its first number for the current year, *The Teacher* began a new series, and added several elements of strength to its already high character. Mrs. *Mary Hargrove Simpson* remains the general editor, and now has as associates the following well-known educators: Louisa P. Hopkins, of Boston; Ellen E. Kenyon and Caroline B. Le Row, of Brooklyn; W. N. Hailmann, of La Porte, Ind.; B. A. Hinsdale, of Ann Arbor; H. M. Leipziger, of New York; and C. M. Woodward, of St. Louis. This journal has been from the start an exponent of advanced modern thought in the domain of education. Its special purpose is to set forth the scientific principles on which the art of teaching is coming more and more to depend, and the working out of which every teacher and school officer must keep track of, if he wishes to keep up with the progress of the time in his profession. The departments of *The Teacher* are Editorial and Miscellaneous, Theory and Practice of Teaching, Correspondence, Reviews, and Notes. Its articles have the character expected in magazine articles, and it may be questioned whether the nature of the journal would not be better indicated if it should adopt the magazine form. (The Teacher Co., New York. $1 a year.)

PUBLICATIONS RECEIVED.

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Harper, W. R., and Tolman, H. C. Cæsar's Gallic War. American Book Co. Pp. 502. $1.20.

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Pickering, Edward C. Variable Stars of Long Period. Cambridge, Mass. Pp. 8.

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POPULAR MISCELLANY.

The First Piece of American Hollow Ware.—In the first of Mr. Durfee's series of articles on Early Steps in Iron-making, in The Popular Science Monthly for December, 1890, "a small iron pot capable of containing about one quart," which was cast at Lynn, Mass., in 1645, was mentioned as having been the first piece of hollow ware made in America. Mr. Durfee added that "this pioneer of all American-made castings was in existence in 1844, but recent efforts [by C. H. J. Woodbury] to ascertain its whereabouts have been unsuccessful." We are informed by the Lynn Daily Item that Mr. Durfee's article attracted the attention of F. W. Pope, of Lynn, who happened to have recently seen the pot, and made a photographic picture of it. We give an engraving of it. The pot is in the possession of the sons of Alonzo Lewis, the historian and poet, whose description of the Saugus Iron Works is quoted by Mr. Durfee. It is an heirloom, having descended to the present owners through their father from "Thomas Hudson, of Linne," the original possessor. It holds less than a quart, and weighs two pounds thirteen ounces. When photographed by Mr. Pope, it was standing on a common tea-plate; and there was room enough on the flat bottom of the plate to accommodate its spreading legs and leave an ample border of flat around them.

Metal Railway Ties.—A large share, probably twenty per cent, of the timber cut in this country is used by the railroads, and an important item in this portion is the quantity used for ties. With the purpose of lessening the drain upon our forest resources, the Forestry Division of the Department of Agriculture is endeavoring to lead the railroads to substitute iron ties for wood. A Report on the Substitution of Metal for Wood in Railroad Ties, made by E. E. Russell Tratman, has been published by the department, in order to furnish the companies with information in regard to the use of iron ties, and thereby facilitate their general adoption. The report is introduced by A Discussion on Practicable Economies in the Use of Wood for Railway Purposes, by B. E. Fernow, Chief of the Forestry Division, in which suggestions are given as to seasoning and preserving wooden ties, the use of improved tie plates, and also in regard to the use of stone and metal for buildings, bridges, etc., of hedges for fencing, and of metal for rolling stock. The report of Mr. Tratman gives detailed information respecting the use of different systems of iron ties in all quarters of the world. Outside of the United States and Canada there are reported 25,000 miles of railroad laid with metal ties. The most in any one country is in British India, where there are over 9,000 miles; Germany has nearly as much; and the Argentine Republic is third, with 3,500. In the United States, with a total mileage of 161,000, or four ninths of the whole mileage of the world, there are only two miles of metal track. Egypt has nearly 900 miles, and the rest of Africa makes up 400 miles more. In little Holland there are 329 miles,

and Switzerland has 397. Allowing for incomplete returns, Mr. Tratman estimates that (exclusive of the United States and Canada) nearly sixteen per cent of the mileage of the world is laid with metal ties, and the use of metal is being extended. Hence, abroad the subject has long ago passed the experimental stage in which it rests in this country. The report contains descriptions of all the most practicable forms of metal ties that have been invented, and a list of all the United States patents relating to metal railway track, numbering 491. The first of these dates from 1839, and the second from 1850. Patents have also been granted for cross-ties or track of clay, concrete, etc., and one for glass ties.

The Tin Soldiers of Nuremberg.—The artists of Nuremberg and Fürth have long been famous for their manufactures of toy-soldiers of lead. The art dates from the Seven Years' War, and was developed under the influence of the enthusiasm aroused by the career of Frederick the Great. Much pains are taken with the sketches of the intended figures, and eminent artists are willing to supply the models. Certain fixed rules have to be adhered to in designing the figures. In colors, deep tints must be avoided, and gaudy hues preferred. The artists must be acquainted with the military costumes of the period to which the soldier they represent belonged. Anachronisms in this matter are fatal. Molds of slate are used for the plain figures, and of brass for those in relief. The figures, having been cast, are taken out and trimmed; then handed over to the women, to be painted; and then to other women, to be packed in wooden boxes.

Rotten Logs as Breeders of Borers.—A newly noticed evil resulting from mismanagement in forest affairs has been pointed out in Garden and Forest by Prof. Fernow. It comes from leaving large parts of felled trees on the ground and allowing fires to run through the woods, by which the multiplication of borers and other mischievous insects is promoted. A large proportion of the beetle larvæ which infest living trees can not exist in a thoroughly healthy and vigorously growing tree; those larvæ in particular which are found in the cambium layer between the wood and the bark would be drowned in the sap of healthy trees. They are, therefore, mostly found in those trees which, for some reason or other, are less vigorous or on the road to decay. When a fire has run through the pine forest, or when the leaf-destroying caterpillar has ravaged the foliage and thus reduced the vigor of the trees, these beetles find a most favorable breeding-place in the weakened trees, and their larvæ multiply rapidly and finish the work of destruction in a short time. For this reason it is often necessary to cut millions of feet of timber or cord-wood at once, or it will be entirely ruined. The frequent forest fires and the failure of the farmer and lumberman in disposing of large parts of the felled trees must be considered as among the principal causes of the prevalence in North America of these insect borers. The flat-head borer of the orchards, the oak pruner, grape borers, a blackberry borer, the apple-twig borer, and several bark borers are mentioned as among the insects the growth of which is encouraged by the prevalence of dead timber.

A Torres Strait Decalogue.—Among the western islanders of Torres Straits, boys, as soon as the approach of maturity is indicated by the appearance of hair on their faces, are taken by their fathers to a sacred spot and there instructed in the duties and dignity of manhood. A number of precepts which are taught during this probation have been collected and are published by Prof. Alfred C. Haddon. Among them are these:

"You no steal."

"If you see food belong another man, you no take it, or you dead."

"You no take thing belong another man without leave; if you see a fish-spear and take it, s'pose you break it and you no got spear, how you pay man?"

"S'pose you see a dugong-harpoon in a canoe and take it, he no savvy, then you lose it or break it, how you pay him? You no got dugong-harpoon."

"You no play with boy and girl now; you a man now, and no boy."

"You no play with small play-canoe, or with toy-spear; that all finish now."

"You no like girl first; if you do, the girl laugh at you and call you a woman." (That is, the young man must not propose marriage to a girl, but must wait for her to ask first.)

"You no marry the sister of your mate, or by and by you will be ashamed; mates all same as brothers." (But "mates" may marry two sisters.)

"You no marry your cousin; she all same as sister."

"If any one asks for food, or water, or anything, you give something; if you have a little, give a little; if you have plenty, give half."

"Look after your mother and father; never mind if you and your wife go without."

"Don't speak bad word to mother."

"Give half of all your fish to your parents; don't be mean."

"Father and mother all along same as food in belly; when they die you feel hungry and empty."

"Mind your uncles, too, and cousins."

"If woman walk along, you no follow; by and by man look, he call you bad name."

"If a canoe is going to another place, you go in canoe; no stop behind to steal woman."

"If your brother is going out to fight, you help him; don't let him go first, but go together."

A Glacial Epoch in the Carboniferous Period. — Data are collated by Dr. C. D. White, in a paper published in the American Geologist, on Carboniferous Glaciation in the Southern and Eastern Hemispheres —based on observations in India, Australia, and South Africa—which show that evidences of glacial action are abundant and marked within an area extending from 40° south latitude to 35° north, and from 20° east longitude to 155° east, and including more than one fourth of the earth's surface. The idea that there was a glacial epoch in later Palæozoic or earliest Mesozoic time has, in the light of these evidences, gained credence steadily since 1872, "until at last it is supported, not only officially, but individually," by nearly every geologist who has specially examined them or studied them in the field. This is also the conclusion generally accepted by European geologists, including Prestwich and Neumayr, who is quoted as saying, in his Erdgeschichte, that there can no longer be any doubt that during the latter half of the Carboniferous period strata were deposited in southern Australia, Farther India, and the Cape region of South Africa, whose material shows all the characteristic features of transportation by means of glaciers.

Packing Fruit for Transportation.—The instructions of the British Pomological Society respecting the packing of fruit for transportation advise that, for protection against injury from pressure, it be put up in boxes or stout baskets; against shaking, by using cases of moderate dimensions in every direction, or cases cut up by partitions, and by laying the separate articles so closely and compactly that they shall just keep each other steady without crushing. Packing material which might communicate an unpleasant flavor should not be used. The bloom of fruits is best preserved when they are packed in young nettle-tops, partly dried, or in cartridge-paper. Grapes carry best if tied down to the bottom of a shallow box, or when each bunch is inclosed separately in a piece of stout cartridge-paper. Melons should be inclosed in cap paper, placed in a box, and surrounded by chaff, bran, or dry sawdust. Peaches, nectarines, and apricots should be carefully inclosed in a piece of tissue-paper, and kept separate from one another by cotton-wool. Plums, when the bloom is important, should be rolled up, six or eight together, in a piece of cartridge-paper, and tied round with matting. When the bloom is not important, they may be packed in strawberry or similar leaves. Cherries, gooseberries, and currants travel very well, under general circumstances, if laid together in small, shallow baskets or punnets. In packing strawberries, raspberries, and mulberries, each fruit should be separately surrounded by one or two strawberry leaves.

The Care of Milk and Cream.—In milk and cream exposed to the air, bacteria readily collect and multiply rapidly. They cause the souring and curdling of milk and induce other changes in it, while their effect on

cream is to aid its "ripening." Dairymen let their cream ripen before churning, because their experience shows that from such cream butter "comes" more readily, keeps better, and is of better flavor than from sweet cream. In a recent paper on this subject, Dr. H. W. Conn states that milk will become contaminated with bacteria if put into vessels in which particles of curd and grease are left sticking in joints and on the sides. Boiling in water will kill the bacteria, but their spores or seeds can not be killed without a higher heat. Hence, to prevent the souring of milk, cans and pans should be set on a stove or in the oven a few minutes after washing. As cold checks the development of bacteria, the milk should be cooled immediately after it is drawn from the cow, and kept as cool as possible. Cream for butter, on the contrary, should be kept in a warm place, so as to favor the growth of bacteria. Dairymen sometimes add a little old cream to a fresh lot as a leaven. Acid is also added for the same purpose, but this is of doubtful use.

A Fire-ball in Art.—In the Madonna painted by Raphael for Sigismondo dei Conti dal Foligno, the Virgin is represented as in the clouds, the clouds rest upon a rainbow, and under the bow is a red fire-ball. Assuming that the introduction of so unique a feature as a fire-ball in a painting of the Madonna is symbolic, Prof. H. A. Newton has inquired into the history of the subject. He finds that on the 4th of September, 1511, there fell near Crema, some leagues southeast of Milan, a number of stones, the results of the explosion of a meteorite, which are described by several authors; and he believes that Raphael intended to represent this aërolite in his painting. He seeks to interpret its meaning by finding what men thought of such phenomena. When the Ensisheim stone fell, nineteen years earlier than this one, near the lines separating the contending French and German forces, the Emperor Maximilian had the stone brought up to the castle, and held a council of state to consider what the fall meant. Sebastian Brant, in a poem describing the fall, speaks of the terror it caused to the Burgundians and French. Eleven years later, in 1503, Maximilian, in a proclamation appealing for aid, included the Ensisheim stone-fall among indications of divine favor. After the fall of 1511, although the papal forces were defeated in battle, the French were forced to withdraw in June, 1512, from Milan and northern Italy. It is natural, then, to suppose that Raphael in the picture united in his painting the fire-ball with the rainbow in order to symbolize divine reconciliation and assistance.

The Highest Mexican Volcano.—One of the results of the recent scientific expedition of Prof. Angelo Heilprin and his companions to Mexico was the establishment of Orizaba as the highest of the giant volcanoes of that country. The barometrical measurements of the four highest volcanoes gave for Orizaba, 18,205 feet; Popocatepetl, 17,523 feet; Iztaccihuatl, 16,960 feet; and Nevado de Toluca, 14,954 feet. In favor of the accuracy of the measurements, Prof. Heilprin refers to the quality of his registered aneroid barometer, which was tested and corrected at Philadelphia before and after starting, at Vera Cruz, and in the city of Mexico; and the fact that all the summits were ascended within three weeks, and were measured with the same instrument, during a period of atmospheric equability and stability which is offered to an unusual degree by a tropical dry season. The measurements bring up the question of what is the culminating point of the North American continent. The only other mountain than Orizaba that need be considered in this connection is Mount St. Elias, in Alaska. The measurements of this mountain, however, depart so widely from one another that we are not yet in a position to affirm, even within limits of a thousand feet or more, how nearly it approaches in height the Mexican volcanoes. The most usual figure in standard publications is 14,970 feet; Malespina found, by taking the angles from Port Mulgrave, 17,851 feet; Tebenkoff reduced this figure by somewhat more than 900 feet. Mr. Dall, in 1874, made angular measurements from four points, 69, 127, 132, and 167 miles away, that gave results varying from 18,033 to 19,596 feet. He does not place great confidence in any of them. In view of the broad divergence existing in the later measurements, and the

fact that all earlier determinations give less than 18,000 feet for the height of Mount St. Elias, Prof. Heilprin intimates that "geographers will probably consider the question of absolute height as still an open one. That the mountain closely approximates the giants of the Mexican plateau is almost certain, but it seems equally probable that its true position is after, and not before, the Peak of Orizaba."

Bulgarian House Communities. — The Bulgarian house communities, according to Mr. J. E. Gueshov, called there *kupshtina*, are very like the *zadrugas* of the Serbs and Croats. The head of the society is called *domakin*, the man of the house, and is usually either married or a widower, but may be a single man. The *domakina*, or lady of the house, is generally the wife of the *domakin*, or the widow of a previous one, or, if there be no such person, the oldest woman of the community is elected to the place. She regulates the work to be done by the women of the household; as, for instance, who is to bake or cook on particular days; and she arranges the domestic labor so as to allow the women time for attention to their children and to other duties. The principle of the community is that each member must work according to his capacity, for the common good. Any one who is dissatisfied with the work assigned to him can leave the community, but the only goods which he is allowed to carry away as his own are his clothes. If one of the women contracts a second marriage with a man who is not a member of the community, her children by her first husband remain in the society, although she herself quits it. When the girls marry, they receive nothing from the community, except a *zestra* of clothes and bed-furniture, for which the bridegroom makes a money payment. These house communities are spread over Bulgaria from Leskovatz on the north to Macedonia. Details are given by Mr. Gueshov of the community of Gornya-Banga, not far from Sofia. Its head is a priest. Some four years ago it consisted of twenty-eight and thirty-five members. With the *domakin*, Todorin, work his six brothers, one of whom is a priest, the second a farmer, the third a shepherd, a fourth the keeper of an inn, and another a tailor. No property is private among them except their clothes. All work for the house community; even the priest, if he gets money from any quarter, from a wedding, christening, or funeral, is obliged to bring it into the common fund. The *domakina*, the wife of Todorin, arranges which of her sisters-in-law shall bake one day and which shall cook. One oven and one kettle suffice for all. Concord and love prevail in the community; and the priest assured Mr. Gueshov that, if they had possessed in severalty, they could never have passed through the terrible period of the last Russo-Turkish War. No legal sanction has been given since the independence of Bulgaria to this customary right, but it remains deeply rooted as an institution in the public mind. A case is told of a member of a community who bought two plots of land and secured a confirmation from a court of law of his property in them. The whole village rose against him, and he was obliged to hand the plots over to the society to be common property. There are also co-operative market gardeners in Bulgaria, who travel about and raise vegetables on plots which they hire. The unit of the gardeners' co-operative society is the working gardener. If a man has gained experience in this calling, he can easily enter one of them, even if he has no money. The union, called a *taifa*, is great or little according to the size of the garden which it is proposed to cultivate, and that of the town which offers a market for their products. The largest shareholders are the master, who holds the purse and keeps the accounts, and the salesman; but the funds of the society are distributed in proportion among the workers in the garden. Other co-operative societies exist among shepherds, reapers, masons, bakers, tinkers, and potters.

Good and Bad Novels.—Whatever influence novels have upon the mind of a reader is due to giving him a wider acquaintance than his own experience affords with life, or what passes for life. Novels deal only with the interesting parts of life, leaving out of sight the commonplace matters which make up more than three fourths of real life, otherwise they would not be read. Good novels represent these interesting features as

they are, and give the real feelings of honorable men and women toward the actions and occurrences which make up the story. Bad novels, on the contrary, make their readers believe themselves and others to be what they are not, disturb their judgments, and fill them with false hopes as to what they may expect at the hands of destiny. Novels impel their readers to pursue the thoughts and foster the emotions of the accomplished or smart heroes and heroines whom they have been led to admire. When these thoughts and emotions are pure, generous, and elevated, fiction becomes an agent for good; but when its model characters are willful, pompous, immoral, and impossibly successful withal, its effect is deplorably degrading.

Sanitary Entombment.—Entombment, or deposition in a mausoleum, is represented, by the Rev. Charles R. Treat, as the mode of disposing of the dead to which the human race, as a whole, has shown the most evident preference. Sanitary entombment is described by him as comprising this feature combined with desiccation, a process which is performed naturally in some atmospheres, and which the author believes can be made artificially practicable, with entombment, everywhere. He proposes, therefore, the arrangement, in buildings like the "Campo Santo" of Pisa, of sepulchres "so constructed that anhydrous air could enter or be made to enter, and withdraw, laden with moisture and morbific matter, which it would convey to a separate structure, where a furnace would complete the sanitary work that the anhydrous air had begun, and return to the external atmosphere nothing that would be noxious." This would retain the form and much of the substance of the body, and subject the noxious, volatile particles to cremation.

Conditions of Vigorous Old Age.—The present greater proportion than formerly existed of men who pass the age of seventy years, reach fourscore, or are active at ninety years, points to one of the brighter phases of our civilization. The association of this vigor with different physical types is suggestive of a certain generality of origin, and encourages the hope that it may be partly dependent on personal conduct. As a first condition toward obtaining effective longevity, Dr. B. W. Richardson advises parents to begin for their children by saving them the infliction of mental shocks and unnecessary grief, and making everything as happy for them as they can. The persons themselves, when older, should avoid grief and eschew hate, jealousy, unchastity, and intemperance, all of which hasten the coming of old age. When old age has really begun, its march may be delayed by rules securing the least friction and the least waste: subsistence on light but nutritious food, varying according to the season, and moderate in quantity; dressing warmly, but lightly, so as to enable the body to maintain its even temperature; keeping the body in fair exercise and the mind active and cheerful; maintaining an interest in what is going on in the world, and participating in reasonable labors and pleasures; securing plenty of sleep during sleeping hours, in a room kept at a moderate temperature; and avoiding passion, excitement, and luxury. The weaker man may thus sometimes show himself the more tenacious of life.

The Chartreuse Liquor.—The Chartreuse liquor is made under the direction of the monks of the abbey of the Grand Chartreuse, in the high Alps of Dauphiny. This abbey is the headquarters of the Carthusian order, which has some fifteen houses in France, Italy, Switzerland, and Austria. The manufacture is carried on by paid operatives, under the supervision of the abbey steward, while the rest of the monks have no concern with it. The population of the village are employed in collecting the herbs, which, mixed with *eau-de-vie*, are distilled along with the spirit. This brandy is purchased, not made at the abbey. Only one of the operations—the mixture of the herbs—is a secret. The manufacture of Chartreuse as a market product has grown up since 1835. Previous to that time it was made only on a small scale as a remedy. There were formerly three kinds of Chartreuse made, the white, yellow, and green; but the white has been abandoned. The green is the strongest and most expensive; and the monks recommend a mixture of one third green and two thirds yellow as the best. A Chartreuse is

made at the Certosa, near Florence, by a few lingering Carthusians of the old society, whose secret is likely to perish with them. The Dominicans of Santa Maria Novella formerly manufactured elixirs and scents, but, according to Chambers's Journal, have been broken up by the Government. The Benedictines make a rival to Chartreuse; and the monks of Tre Fontane, near Rome, make a "Eucalyptica," with *Eucalyptus;* but Chartreuse continues to enjoy the higher esteem.

The Massachusetts Institute of Technology.—The twenty-fifth anniversary of this highly respected school occurred in 1890, and was commemorated by an address reviewing the career of the institution, which was delivered by Augustus Lowell. The Institute was founded by the eminent geologist, Prof. William B. Rogers. The work of organization was retarded by the civil war, but in February, 1865, the school opened with twenty-seven students. In 1872 the number had increased to three hundred and forty-eight, and then came the financial crisis, which very nearly wrecked the undertaking. It survived, however, and the revival of business brought it a new era of prosperity, so that its students now number nine hundred, with ninety instructors and eleven courses of study. The purpose of the Institute of Technology is to prepare men to direct those great industrial enterprises and public works which require a thorough training, based upon an adequate acquaintance with science, for their successful prosecution. Additions to the facilities of the school have been made in rapid succession, often looking to the future to supply the requisite means. This institution was one of the first in the world to instruct chemistry classes by the laboratory method. Its first chemical instructors were Charles W. Eliot, now President of Harvard, and Prof. Frank H. Storer. A physical laboratory was established at about the same time. In 1871 a laboratory for the course in mining engineering was begun, by the purchase of apparatus in which economic quantities of ores could be treated. Two years later a sixteen-horse-power engine, with apparatus for engine and boiler tests, was provided. In 1881 a laboratory of applied mechanics, devoted especially to tests of building materials, was added. A distinct course in electrical engineering was organized in 1882, and this study had its special laboratory fitted up in the new building which the growth of the school required to be erected in the following year. Six years later another new building was put up, and during all these years delicate instruments and powerful machines of great variety have been continually added to the equipment of all departments. In carrying on its work the Institute has several times incurred heavy debts, most of which have been canceled by the efforts of its friends. It still owes, however, the cost of its latest building ($120,000). The graduates that it has been sending out for over twenty years are doing valuable work in the several engineering professions, and as instructors in various departments of science and technology, while the example of the Institute has done much to extend the laboratory method of science-teaching.

The Nature of a Flash of Lightning.—Describing the electric discharge of a flash of lightning, Prof. Oliver J. Lodge compares the cloud and the earth as forming the two coats of a Leyden jar, in the dielectrics of which houses and people exist. The occurrence of the discharge is determined at the moment when the maximum electric tension which the air can stand is reached. "At whatever point the electric tension rises to this value, smash goes the air. The breakage need not amount to a flash; it must give way along a great length to cause a flash; if the break is only local, nothing more than a brush or fizz may be seen. But when a flash does occur, it must be the weakest spot that gives way first—the place of maximum tension—and this is commonly on the smallest knob or surface which rears itself into the space between the dielectrics. If there be a number of small knobs or points, the glows and brushes become so numerous that the tension is greatly relieved, and the whole of a moderate thunder-cloud might be discharged in this way without the least violence. This is by far the best way of protecting anything from lightning: do not let the lightning-flash occur if you can possibly avoid it. But one can not always prevent it, even by a myriad points. A good deal more might be

done in this direction than is done; but still, sometimes a cloud will descend so quickly, or it will have such a tremendous store of energy to get rid of, that no points are sufficiently rapid for the work, and crash it all comes at once." Where a flash occurs, a considerable area is relieved of strain, and the rush of electricity along the cloud and along the ground toward the line of flash sets up a state of things very encouraging to another or secondary flash or flashes, practically simultaneous with the first.

Weather Plants.—Garden and Forest quotes from a writer in the *Illustrirte Gartenzeitung* of Vienna, who, while he disputes the excessive claims that have been made for certain "weather plants," points out that a modest degree of power in forecasting atmospheric changes is possessed by a multitude of common plants. The pleasant fair-weather odor of *Galium vernum* (Our Lady's bed-straw) becomes strong and pungent at the approach of rain. The leaves of *Carlina vulgaris* close before rain. *Calendula pluvialis* (marigold) predicts rain when its flowers remain closed after seven in the morning. *Oxalis acetosella* (wood-sorrel) closes its leaves at the approach of rain or cold. *Lapsana communis* keeps its flowers open at evening if it is to rain the following day, but closes them if fair weather is coming. The leaves of *Draba verna* (whitlow-grass) droop before rain. *Alsine media* predicts a clear day if its flowers open about nine o'clock, and a second one to follow if they remain open as late as four in the afternoon.

A Novel Mound-builders' Structure.—Prof. F. W. Putnam described, at the meeting of the American Association, a curious earthwork at Foster's Station, in the Little Miami Valley. The mound is in the angle of a creek and the river. It is a flat-topped circular hill, about half a mile round at the rim, and has been formed by the river and creek washing away drift material on either side. Around the brow of this hill is, at some parts, a ridge, at others no elevation above the surface. The ridge is made up of well-burned clay, and includes masses of burned limestone, clinkers, charred logs, and heaps of ashes, from a bushel to forty bushels in bulk. It is more than half a mile long, from twenty to fifty feet wide, and from eight to ten feet deep. To have burned all this clay must have required a heat like that of a Bessemer furnace. The rim of burned stuff is backed by an escarpment of well-laid stone wall to keep the burned material in place, which probably once extended clear down to the water; but the creek has worn its way down and to a considerable distance from the wall. No bones and only a few pieces of pottery were found. The fires could not have been those of charcoal-pits, and the place was not a limekiln. An immense mass of fuel must have been collected to burn this quantity of clay and stone. When asked what he thought was the character of the work, Prof. Putnam said that he had not carried the excavations far enough to formulate a statement.

NOTES.

THE Hon. David A. Wells has been awarded a gold medal by the jury of the group of Social and Political Economics of the French Exhibition of 1889. This recognition of the great services he has rendered in that branch is all the more significant because it comes to him, a plain-spoken free-trader, from a leading protectionist nation.

ONE of the subjects touched upon by Dr. Fernow, in his Forestry Report for 1889, is osier culture. Of the many kinds of willows, but few are osier willows fit for basket-work. Some coarse baskets are made from our native willows. For better work, one of the European kinds—the red osier—is grown in this country, but the finest baskets are almost wholly imported. A large number of the hands employed in the salt-works around Syracuse in summer occupy their winters with basket-making. In 1887 Dr. Fernow obtained from an Austrian grower cuttings from some seventy varieties of osiers, which were distributed to the agricultural experiment stations. Some information has thus been gained in regard to the growth of these plants in our climate, but further trials are still needed.

THE first rain-gauge, according to Mr. G. J. Symons, was designed by Sir Christopher Wren in 1663. Sir Christopher also designed the first recording gauge, but the instrument was not constructed till 1670. The earliest known records of rainfall were made at Paris, in 1668; Townley, Lancashire, in 1677; Zurich, in 1708; and Londonderry, in 1711.

In an address before the Medical Society of Pennsylvania, Dr. Thomas J. Mays presents evidence for doubting the view that consumption is contagious, and closes by saying that "never was an *ignis fatuus* pursued which left more promises broken and greater anticipations unfulfilled than the bacillus theory, so far as it stands related to the prevention and treatment of pulmonary consumption."

M. Moissan has detected free native fluorine in the fluor-spar of the variegated vein that occurs in the syenite of Guinchay, near Lyons. He and M. Henri Becquerel have ascertained that the mineral on being crushed exhales a pronounced odor, something like that of chlorine, but more like the odor of fluorine. The gas thus disengaged displaces the iodine in iodide of potassium, so that starch is turned blue on contact with it; and it retains this property after the stone has been heated to 200° C.—a temperature at which ozone, to which the action might otherwise be attributed, is destroyed. It does not precipitate silver from its nitrate, as chlorine does. With water it forms a liquor which corrodes glass and attacks silicon at ordinary temperatures. It is fluorine occluded in the mineral.

In reply to a suggestion that the Germans owe their success to a habit of drudgery acquired in school, the late R. H. Quick, author of Educational Reformers, writes to The Spectator that "without desire—or *interest*—the higher powers of the mind can not come into play; and the habit of painstaking will never be acquired by any amount of 'slaving' away against the grain. Drudgery that is self-imposed, or accepted from a sense of duty, or the desire of some foreseen results, is one thing; to be kept slaving away by your schoolmaster is quite another." He combats a statement of The Spectator that "you can habituate yourself to work ten hours a day as easily as eight," and says, "I have known the experiment of ten hours a day tried, and a very inferior quality of work has been the result."

Some curious instances of individuality—in density of population, wealth, mobility, birth, marriage, and death-rate—have been discovered by M. Dumont in the small towns of France. With one exception, the eleven rural communes in the outskirts of Caen are being depopulated. Great mobility in the rural population is generally associated with a low birth-rate, great fixity with a high one. Side by side in the same department, and even in the same canton, are very different birth-rates. In one canton the birth-rate was steadily low for many years, and then a remarkable rise took place. Equally curious wants of relation are betrayed between the marriage-rates and fecundity.

According to an official report, 1,009 fathers of families in the province of Quebec applied last year for a bounty of 100 acres of crown land which had been offered for every family of twelve living children, and 12,447 children were represented in the applications. The new land-owners are to be collected in groups, which may form parishes later on.

It is intended by the committee of the Royal Society on that enterprise to give the contemplated memorial of the late James Prescott Joule an international character, and to make it contributory to the encouragement of research in physical science. A portion of the money obtained will be applied to a medallion portrait, and the rest directly to this purpose, to be used in the manner that may appear to the council of the society most suitable.

A commission has been appointed by the French Society of Physiological Psychology to investigate the phenomenon in which one imagines he sees or hears an absent person.

In a paper on Shakespeare's References to Natural Phenomena, Miss E. Phipson, after noticing that the play of Richard III was especially rich in such allusions, pointed out that while most poets only found Nature useful for purposes of comparison, Shakespeare was fond of tracing a sympathy between Nature and the works of man. While Shakespeare was the richest in this sort of reference, Drayton came nearest to him, and Chapman followed close. Peele and Greene were essentially artificial in their allusions, and Marlowe almost entirely classical. Shakespeare seemed to love the sun, which to him represented the spirit of good in the world, and to hate the night.

The Rev. George Brown, Superintendent of Australasian Wesleyan Missions, describes the following curious ceremony which he experienced at Guisopa, on one of the islands of New Guinea: "I was standing among the crowd, when one of the principal men came quietly behind me, and, before I knew what he was up to, he blew a mouthful of chewed betel-nut, masooi bark, and spittle over me, which fell in fine spray over my head, neck, and shoulders. The governor and his party, as I found out afterward, had been treated in the same manner prior to my arrival. I suspected the reason for this proceeding, and so did not say anything to the man. It is done, I think, to guard against any evil spirits who might be accompanying us, and as a sign of amity, and that we were free to remain."

Certain low castes of the Vaishnava sect in the Kistna district, southern India, bury their dead, according to Mr. A. Rea, in kistvaens, as follows: "The body is laid horizontally in a shallow grave, the earth is heaped over it in a long, narrow mound, and these kistvaens are then placed over it. They do not approach a square as in the an-

cient examples, but bear a proportion to the size of the body. At the head and feet are small upright slabs about two feet broad; long slabs are placed upright at the sides, and another of sufficient length and breadth to cover these four upright stones is laid on the top. In some instances a separate stone is placed upright at the head of the grave."

MR. J. R. WERNER has, in his account of his visit to Stanley's rear guard, some pointed remarks on the healthfulness of Nature as compared with the unsanitary conditions induced by civilization. He says: "Nature, when left alone, does her own scavengering; but as civilization advances, the works of man often interfere with the natural drainage, without providing any substitute; and it is only when the population has been decimated by disease that men's eyes are opened. . . . The primitive savage living in his hut has no need of dust-bin or dust-cart. The ants from the large hill close by will soon make short work of any meat he may have left on the bones; the sexton-beetle will soon bury what remains out of sight; and the wind and rain sweep all feathers and dirt into the river. . . . As civilization advances, roads are made, the ant-hills get destroyed, and hawks and carrion birds disappear before the death-dealing shotgun. The natives congregate together in large towns, without any improvement in their sanitary arrangements, where the salutary effects of wind and rain are probably neutralized by the way in which the streets are built; and so things go on till disease is generated and men fall by hundreds."

A REWARD was offered by the French Government in 1882 for killing wolves. In the next year 1,316 wolves were destroyed; but the number has since decreased almost yearly as follows: 1,035 in 1884, 900 in 1885, 760 in 1886, 701 in 1887, 505 in 1888, and 515 in 1889. It is believed that very soon no specimens of the animal will be left in France except those which occasionally reach it from neighboring countries.

OBITUARY NOTES.

PROF. JULIUS E. HILGARD, late Superintendent of the United States Coast Survey, died at his home in Washington, May 8th, in his sixty-seventh year. He was born in Bavaria, the son of a jurist of much literary cultivation, and when nine years old came with his father to St. Clair County, Illinois. Here the father settled on a farm and introduced the cultivation of the vine, in connection with which he discovered and made known the merits of the native Catawba grape. Young Hilgard began the study of engineering in Philadelphia in 1843, and two years later entered the service of the United States Coast Survey, in connection with which most of the work of his life was done, and of which he was one of the most valuable and efficient members. In 1881 he became Superintendent of the Coast Survey and so remained till 1885, when he fell a victim to political operations. He was ill at the time, with disorders from which he never recovered. A brief sketch of his life, and a portrait, were published in The Popular Science Monthly for September, 1875.

COLONEL ÉMILE GAUTIER, who, besides his military career, was distinguished in astronomy, died in Geneva, February 25th, of heart disease. He was born in 1822; was directed to astronomical study by his uncle, Alfred Gautier, of the observatory; was a pupil of Leverrier's, and assisted him in his calculations of the perturbations of Uranus; published an essay on the theory of the perturbations of the comets; determined the elements of the planet Metis; observed the solar eclipse of 1860 at Tarragona, Spain, and published his observations; recognized the true nature of the solar prominences, and defended his opinions; became director of the observatory at Geneva on the death of Plantamour, and added many new instruments to the apparatus of the establishment.

PROF. JOSEPH LEIDY, of the University of Pennsylvania, and President of the Philadelphia Academy of Natural Sciences, died April 30th, in the sixty-eighth year of his age. He was distinguished in different fields of science, but most eminently in biology, in which he published more than eight hundred papers. He was a member of the principal American and numerous foreign scientific societies. A sketch of his life and work, by Edward J. Nolan, was published in The Popular Science Monthly for September, 1880.

JOHN LE CONTE, Professor of Physics in the University of California, died in Berkely, Cal., April 29th, aged seventy-two years. We have recently given, in The Popular Science Monthly for November, 1889, a full sketch of his life and labors, by his relative and co-worker in physical investigations, Prof. W. Le Conte Stevens, with a full list of his publications.

THE death has been announced, in the latter part of March, of M. Auguste Thomas Cahours, a distinguished French chemist, in the seventy-eighth year of his age. He was successively connected with the chemical departments of the Central and Polytechnic Schools in Paris, and was afterward assayer at the Mint. He was one of the earliest to promulgate the later chemical theories. He was the author of works on the density of vapors, the determination of the indexes of refraction of liquids, metallic radicles, sulphurets, etc., and of Elementary Lessons in Chemistry, a text-book highly esteemed in France.